THE

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THE

UNIVERSAL ELECTRICAL DIRECTORY

1901 Edition

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THE ELECTRICAL POWER BILLS OF 1900.

MR. W. L. MADGEN'S paper on the above subject, read before the Institution of Electrical Engineers on Thursday last, was composed of some reflections and a moral. The reflections were of the bitter sort called up by the contemplation of the past history of electrical engineering in this country. The moral is one for the Institution to consider well; and we shall be curious to see the result. The *rôle* of Jeremiah is not a pleasant one, but the author, in company with most thinking men amongst British electrical engineers, has assumed it; and we cannot give too much ear to the outcries, dismal though they be, of those who point to the facts and the causes of the evil days upon which the electrical industry in Great Britain has fallen.

The earlier portion of the paper was devoted to a historical account leading up to the passage of the Power Bills last year; then followed an analysis of the pros and cons in connection with these far-reaching schemes; and the climax was reached in the suggestion that the Institution should appoint a special committee to consider what steps should be taken to amend or remove the restrictions which hamper the electrical industry. We may usefully pass over the historical matter, with the lamentations which it evokes, and consider for a moment the essential argument for and against these undertakings. Their advocates claim broadly that they will offer the advantages of electrical energy for light, power, and locomotion to extra-urban districts, which must otherwise remain permanently deprived of them; that to town and country alike they will bring electricity supply within the reach of the poor man as well as the rich, and finally, that they will play an important part in solving the grave social problem of the present and increasing congestion of population and trades into concentrated areas. The main argument against them is, that they put back the hands of the clock of time, when a triumphant democracy, founded on socialistic principles, shall have absorbed into its collective being all the instruments of production and distribution; for towards this end the craving for municipalisation of every commodity of public utility, from the police force and public wash-houses up to electricity supply, is surely hurrying us. Thus stated, it will be seen that the issue is a large one; and the contentions of the parties penetrate so deeply into the political and social strata of our national life, that nothing short of a prolonged campaign of united effort among all those whose interests and convictions are opposed to the gospel of collectivism can re-establish the equilibrium which we find existing in other countries.

How then can we set about the task?

The answer we think is that the stream must be diverted at its fountain head—the Legislature. Some 700 gentlemen, meeting in Westminster, have demonstrated unsatisfactorily in the past that they can wreck the coach of electrical

progress for a generation by ignorant or ill-judged measures. Legislators, like volts, select the path of least resistance; and the direction and pace of their efforts have been set by the doctrinaire views of social democrats and town councillors ambitious for the millenium, local repute, or personal profit. In the absence of an organised opposition to these views, the Legislature has taken the obvious course of treating them as the voice of the people, and therefore heaven-sent. If the balance is to be restored, an opposing force of equal weight must be thrown into the other side of the scales of public opinion on which the Legislature keeps its eye fixed. So far as the electrical industry is concerned, the Institution of Electrical Engineers has weight beyond any other body, association or interest; and we think the time has come when it should emerge from its academic reserve, and join with the Electrical Section of the London Chamber of Commerce and other forces in making known to our law-givers that the path they are pursuing leads not only to the wreck of the electrical industry, but thence onward to the undoing of that edifice of commercial and industrial supremacy based on individual enterprise which is the heritage and pride of the Anglo-Saxon race.

THE QUESTION OF DEPRECIATION.

In dealing with the accounts of electric supply undertakings, the question of a fund to meet the cost of renewals and depreciation of plant is of considerable importance. In the case of companies working under provisional orders, the Board of Trade prescribes a form of accounts, under which depreciation in respect of leasehold works, buildings, plant, machinery, &c., is carried to a depreciation fund account, the amount being invested, and particulars of the investments specified. This account is in addition to the cost of repairs and maintenance of buildings, engines, boilers, dynamos, exciters, transformers, motors, &c., other machinery, instruments and tools, accumulators and accessories, which are placed to the debit of revenue account.

In Corporation electric supply undertakings, the practice of dealing with the question of depreciation is very irregular, and in the majority of cases it is altogether ignored. In some instances, such, for example, as Glasgow, the accounts are properly kept, and the following scale of depreciation is adopted, which amounts to about 4 per cent. on the capital, viz.:—

Land and buildings	1 per cent.
Machinery	7½ „
Accumulators	10 „
Mains	2½ „
Meters	6 „
Instruments	5 „
Counting-house furniture	5 „

In addition to this provision there is the sinking fund for repayment of borrowed capital, interest, of course, being charged to revenue. The net result of the trading at Glasgow for the eighth year of supply is stated to be £40, the charge for electricity being 3·51d. for private, and 1·64d. for public lighting; the quantity of energy sold 4,250,669 units. Glasgow is an exceptional example of a city where an electricity supply should flourish, and it appears to prove that, with reasonable charges and properly kept accounts, there is really nothing left for reduction of rates out of surplus profits in the municipal trading.

Practically, the enterprise pays to the extent of the interest on capital, which would enable a company to pay a small dividend to its shareholders, but which is not available for contribution in aid of rates, as the capital is borrowed, and the interest goes to the lenders.

The Town Council of Edinburgh discussed the question of a renewals fund at a meeting on January 10th, 1899, when the Lord Provost said that "any man of common sense in a manufacturing business, with machinery which was easily worn out, would, before counting his profits, estimate how much his machinery had depreciated during the year. Having ascertained that, he would put aside a sum to meet that depreciation. Now, if there was anything certain about the conduct of the electric light business, it was that electrical plant depreciated rapidly." And he said also that "there were only two ways of providing for renewals, either by borrowing anew, and adding it to their capital account, or by taking it from this proposed renewals fund."

Notwithstanding these well-expressed principles of accountancy, there are but few electric supply undertakings in the hands of local authorities which provide a depreciation fund, and they are probably encouraged in their improvident system by the opinions of those who advise Town Councillors, and preach the false doctrine that the sinking fund for repayment of capital borrowed to pay for the plant renders any depreciation fund unnecessary.

The effect of this method of keeping the accounts is to give a fictitious record of the results of the trading.

Take, for example, the accounts of a moderate sized town like Dewsbury, a manufacturing centre, with a population of about 30,000. The loans outstanding are about £800,000—the water, gas, and electricity supply—all in the hands of the municipality. The electricity supply commenced in 1894, and the accounts for the year ending March 31st, 1900 (that is to say, for the fifth year of working), give the following results:—

Capital expenditure			£33,155 6 3
Revenue			4,031 5 7
Cost of generating and distributing current	£2,085 8 5		
Repairs and maintenance... ...	204 17 1		
Interest	795 3 3		
		3,085 8 9	
Alleged surplus			£945 16 10

If depreciation at the rate allowed by the Glasgow Corporation, viz., 4 per cent. on capital expenditure, were provided for, it would amount to £1,326, leaving about £381, in addition to the sinking fund of £748 16s. 10d., to be supplied by the rates, and yet it is claimed that the trading has resulted in a surplus of £202.

Another case will illustrate the misconceptions that arise from the methods of rendering municipal electricity accounts. We take the town of Canterbury, for which a surplus of £406 is claimed on the first year's trading, a statement calculated to mislead other local authorities who are considering the important question of pioneering an electricity

supply business, and are inquiring into results in other towns,

In this case the first published accounts showing the surplus referred to, take no account of an adverse balance in the previous year's account of £450 1s. 1d. paid out of rates, and no provision whatever for depreciation, the entire charge against revenue for repairs and maintenance being £37 3s. 11½d. on a capital expenditure of £32,453, say 2s. 3d. per cent. If the Glasgow system of accounts were adopted, a depreciation fund equal to 4 per cent. on £32,453 should be provided, and this would add £1,296 to the total before anything could fairly be contributed to the rates.

It behoves all local authorities who study the experience of other towns as guides to what they should do in their own districts, to keep this question well in view, besides the varying conditions of supply which depend upon local circumstances and govern the demand, especial care being exercised in comparing results in towns essentially different in character. Thus to argue that, because cities like Edinburgh, Glasgow, Liverpool, &c., show a surplus, therefore Hendon or Enfield can also be worked at a profit as a municipal undertaking, is absolutely absurd.

The probability of a satisfactory load factor is of the utmost importance in considering the prospects of success, and this can only be obtained by securing an all-day demand on the works for power and traction, as well as for light during the hours of darkness, a condition which can only arise under a system of supply over large areas embracing towns with varying demands for industrial purposes, railways, &c.

These considerations are too often lost sight of when Councillors are jumping to the conclusion that success in one town must mean similar results in all. The opening of the works at Fulham has been heralded by the usual flourish of trumpets in support of municipal trading in electricity, and the ratepayers are assured that it is going to pay, because five other London municipalities show profits upon the last accounts published. At the risk of making the ratepayers uncomfortable, we will suggest their examining the accounts referred to, subjecting them to a comparison with the Glasgow results to which we have referred.

The surplus income of all the five undertakings is alleged to be £18,758, and the writer of an article in the *Daily Telegraph* goes on to say that this amount is "after all charges have been met and provision made for interest and sinking fund. The amount is, consequently, a sum earned by the municipality and available towards the relief of rates." The capital expenditure of the five undertakings is as follows :—

Hammersmith	£104,498
Hampstead	162,212
Islington	259,562
Shoreditch	170,383
St. Pancras	288,146
	£984,801

With the exception of the nominal amounts of £21 in the case of Islington, and £112 in the St. Pancras accounts, not a farthing has been provided for depreciation of plant —so that if the Glasgow system of accounts be adopted and 4 per cent. charged, instead of a surplus of £18,758 there would be an actual loss of £20,500 to be paid out of the rates! The article from which we are quoting is not a safe guide for the ratepayers. It gives a list of other metropolitan towns where provisional orders have been obtained by local authorities, with the inference that they will also follow in the footsteps of Fulham; but there is at least one of the places mentioned where the Council has consented to a company undertaking the supply, viz., the important Borough of Lewisham, which possesses a provisional order obtained at considerable cost to the ratepayers, but which has set it aside in order to get rid of the responsibilities of working it, and private enterprise comes to the relief of the ratepayers!

In the article we refer to, the old fallacies are trotted out —of municipalities having to pay "no directors' fees, can command the best engineering advice, and can raise capital more cheaply on the security of the rates than a private undertaking can ever hope to do."

The fact is, that companies are infinitely better off than local authorities with respect to capital. They have no interest to pay unless they make profits, whereas the municipalities, trading without capital, have to borrow and pay interest whether they make profits or not. Then, the companies do not pay extravagant fees in order to command the best engineering advice. In one metropolitan borough the fees of the consulting engineer amount to over £12,000 on the first installation, and in a report before us, estimating the first cost of the scheme of electricity supply proposed to be carried out by a joint committee of the Councils of Edmonton, Enfield, Southgate, Tottenham and Wood Green, the legal, expert, and engineering fees are estimated at £23,000, upon a total outlay (including the said fees) of £345,000.

As to directors' fees, they would be amply covered by the interest on the amount paid to the consulting engineers, who obtain their 5 per cent. on the capital expenditure.

If local authorities desire to be the traders in electricity supply, they should, at all events, embark on the business on prudent lines, or leave to expert private companies the initial risks of pioneering the undertaking, and at the end of a reasonable term of years, when the business is established, acquire it on fair valuation terms.

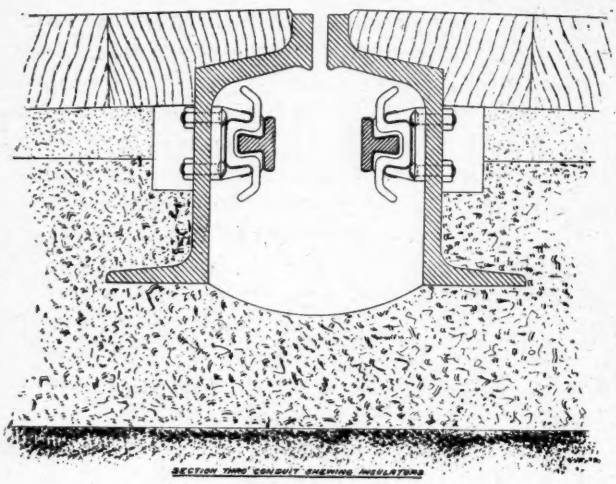
Telephone Wires and Traction.—There appears to be a general opinion abroad that the danger of accident from the fall of telephone wires upon trolley wires is a matter that cannot be guarded against further than by the provision of guard wires or guard netting. We think that the jury in the recent Liverpool case sounded a truer note when they made the very obvious remark that had the span of telephone wires been shorter it is probable they would not have given way. This is a simple matter, but it is one of great importance. It is indisputable that telephone wires do cross streets at a most acute angle, and we have often noted spans of a seriously excessive length. Indeed, no effort appears to be made to avoid these excessive spans. If, however, it were compulsory to employ right-angled crossings only, a very old suggestion, by the way, it is hardly likely that the wires would break even with a snow load when in such short spans, and if ever a wire did break it is most probable that it would fall clear of any trolley wires beneath. Accidents due to electrical currents are far more frequently the result of the breakage of telephone wires than of high tension wires, so far as the initial causes are concerned, and it seems reasonable that telephone wires should be made to cross a street at right angles, thereby diminishing the risk of breakage to a minimum and also minimising the results of a break should one occur. At present the telephone wires are carried across streets in a most haphazard manner at every kind of angle.

D

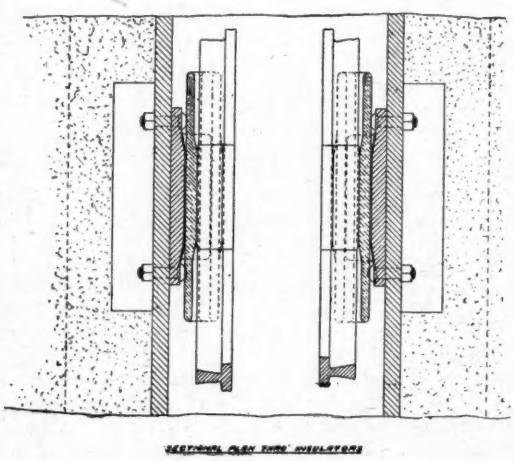
A NEW SLOTTED CONDUIT.

This conduit has been designed with the primary object of reducing the great objection to open slot conduit systems as now constructed, namely, the enormous initial cost due to the necessity for the removal of water, gas and other pipes to allow of the depth of excavation required.

It is impossible to accurately estimate the probable cost of this disturbance of existing pipes, but it is stated that it may be taken at £7,500 per mile of single track, under the most favourable conditions; so that for a system comprising, say, 5 miles of double track, £75,000 would have to be expended on this work alone, and the tramway receipts would have to pay the interest on this lost capital in addition to that usefully expended on construction. The reason for this enormous expenditure is that the conduits up to now have been made deep so as to allow of a sound mechanical construction and efficient drainage, but the "improved



SECTION THRO' CONDUIT SHEWING INSULATORS



SECTIONAL PLAN THRO' INSULATORS

patent slotted conduit," which only requires a maximum excavation of 18 inches, is said to have all the advantages claimed for the deep conduit without necessitating this outlay.

The inventor claims that there is no necessity for the conduit to be made or considered a receptacle for all the slush and water that will collect in the road, since the actual formation of a road tends to drain the surface water away from the centre to the sides, and besides in laying a tram track it is the usual practice to make the centre of the track higher than the rails; there is, therefore, no reason why the top of the slot should not be made and maintained throughout its entire length the highest part of the road. In the case of a double line the centre of the road between the two tracks can be independently drained either by drain rails or by gratings, so that if the surrounding levels are properly considered, it is only necessary to provide for water and mud which actually fall into the slot; this can be reduced to a minimum by the use of an electrically propelled brush, and in a similar manner that which does gain access to the conduit can be easily removed. However, to avoid the flooding of the conduit, through the bursting of water mains or any such accident, a drainage system is provided capable of carrying off large quantities of water.

It will probably be said that the extra cost of cleaning the conduit and brushing the track as suggested would be considerable, but this is not so, as two or three men provided with mechanical tools could easily keep a large system of lines in a perfect working condition, without any disturbance to the traffic, for a sum representing the interest on a very small part of the capital saved in construction.

The sides of the conduit and slot are formed by pairs of specially designed rolled steel Z-shaped sections of suitable length, separated at the ends, and about every six feet these are bolted down to iron sleepers set in a concrete bed; the tram rails rest on the raised portion of the bed and are securely bolted to the iron sleepers, being also tied to the sides of the conduit by tie bars.

Interposed between and bolted to the ends of each pair of Z-shaped sections are iron frames which form the sides of the conduit between the sections. Iron access doors are hinged to these frames, so that when closed they complete the continuity of the road surface and slot in the intervals between the pairs of Z-shaped sections, and when open give free access to the conduit for cleaning, renewal of insulators and withdrawal of plough when necessary.

The bed formed by the sleepers and concrete and the Z-shaped sections is so proportioned that the top of the slot is maintained at a higher level than the tram rails, so that the surface water drains away from it.

At about every 40 yards the conduits are drained into sumps, but this distance is settled after special attention has been paid to the surrounding levels.

In the case of a double track the centre of the road is also drained into these sumps, either by gratings over the sumps or by draining the rails in the ordinary way.

The sumps are fitted with iron buckets so as to facilitate cleaning, and are either connected together by a specially laid drain or are independently connected to the existing sewers.

The insulator holders are bolted to the Z-shaped sections within reach of the access doors, and are provided with grooves lined with suitable packing to carry and protect the insulators. These holders, and the Z-shaped sections for several inches around the holders, are painted with composition to prevent condensation of moisture.

The insulators are provided with projections to slide into the holders, and grooves to receive the conductors, which are in turn lined with suitable packing at insulating points. The insulators extend above and below the conductors and on both sides of the insulator holders to protect the back from dirt and moisture, thus maintaining a high insulation. By this arrangement a very strong support is given to the conductors, and at the same time the liability of damage to the insulators through strains on the conductors is reduced to a minimum. The insulators can also be readily removed through the access doors for cleaning or renewal without removing a bolt or disturbing the continuity of the conductors.

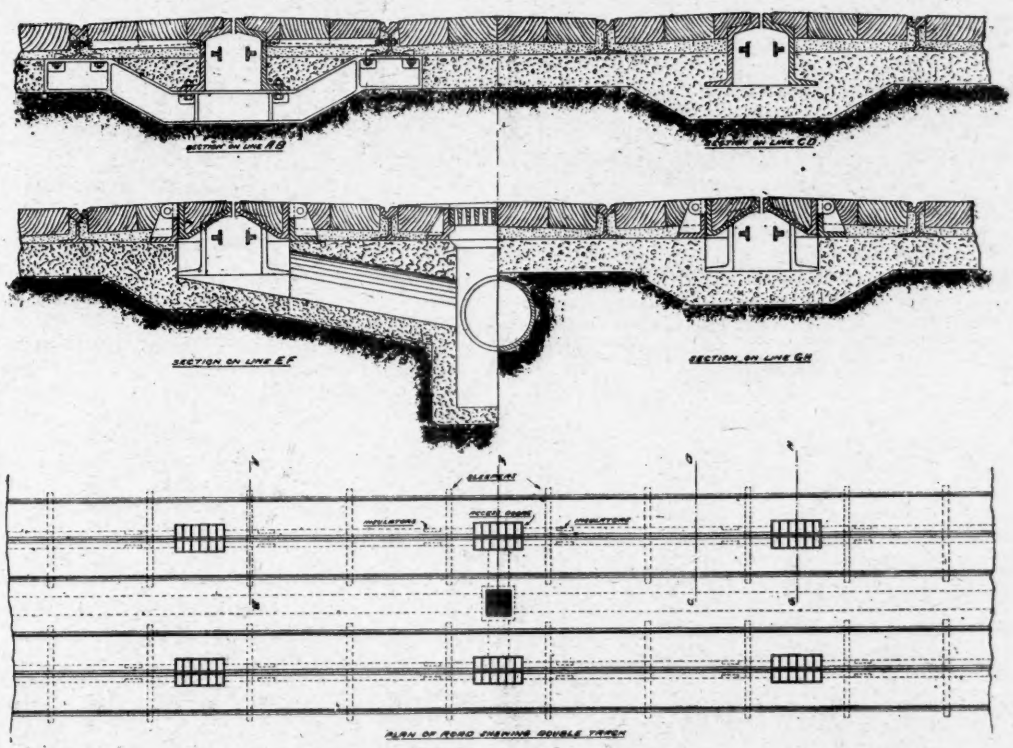
The conductors are made up of sections, anyone of which can be readily removed and replaced through the access doors. By this method of placing the access doors between the insulators, instead of immediately over them, the number is said to be reduced to one-half. The same access doors admit of the conduit being easily cleaned, conductors removed, insulators inspected, and the plough withdrawn; they are strong, and are designed in such a way as to receive the paving used and so offer a similar surface to horse traffic. Instead, therefore, of a number of small hand covers, a few large doors suffice, which can easily be opened by men provided with the necessary keys.

The cableways can be laid in any suitable place, and connection made to the conductors under the access doors. For

this system, therefore, it is claimed that it can be rapidly laid without any disturbance to existing pipes, easily drained and cleaned, that high insulation can be maintained, and that it offers a minimum disturbance to the ordinary road surface when completed,

The cost of 1 mile of double track under ordinary conditions, and paved with wood, drained and complete in every respect, is estimated at about £18,000; it is impossible to give an exact estimate without knowing the intended locality, but the cost should in no case exceed the above sum, and would probably be less.

The most remarkable feature of this novel design appears to be the combination of the slot rails with the walls of the conduit, calling for a very great weight of iron in the construction—the Z-rails alone weighing, according to the drawings, about 400 lbs. per yard of single track. Seeing that the overhang amounts to nearly 5 inches, and that the Z-rails are supported only by their lower flanges and by the tie-bars, it is open to question whether even this weight would provide sufficient stiffness to prevent the slot from closing under the stress of heavy traffic. So far as we can see, the iron frames which carry the access doors are supported only by the *ends* of the Z-rails, and the doors overhang about 10 inches from their hinges; as they are liable to the impact of a wheel with a load of several tons jolting over a casual obstruction, giving a dead blow of great severity, they must be of very great strength to endure.



A New Slotted Conduit.

The cast-iron sleeper, which takes the place of a yoke, is shown bedded upon the subsoil without any concrete; adding a layer of concrete only 4 inches thick, the net depth of the excavation would be 22 inches instead of 18.

The length of the sections into which the conductor is divided is not stated, but it cannot exceed the distance between two access doors (18 feet to scale) if they are to be removable through the doors; hence there will be a bonded joint in each conductor at each door. Further, as the insulators average 9 feet pitch and there is a door every 18 feet, instead of 15 feet as is customary, we fail to see any marked advantage either in the number of doors or in that of the insulators. The insulators are certainly novel and ingenious in design; but are they strong enough? There appears to be nothing to prevent them from working out sideways, in which case the conductor drops on the iron jaw of the insulator holder and makes earth. How would the insulators fit on a curve?

On the whole, we cannot hold out to the inventor any prospects of his design being adopted in practice, despite its ingenuity.

THE GENERATION AND TRANSMISSION OF ELECTRIC ENERGY AT AND FROM COAL PIT CENTRES.

By B. H. THWAITE, C.E.

When the author first formulated the pioneer projects of electrical transmission of power from the coalfields over nine years ago, the science of long-distance electric transmission was in the early stages of its practical evolution. The author, in the formulation of a practical project, had the valuable collaboration of Mr. Huber, of the Maschinen Fabrik Oerlikon, Mr. C. E. L. Brown, now of the famous firm of Brown, Boveri & Co., and Mr. James Swinburne.* The two former experts were, to a considerable extent, responsible for the success of Herr von Dolivo Dobrowolsky's design of the remarkable pioneer installation of long-distance transmission between the towns of Lauffen and Frankfort, a distance of 112 miles, tested by Prof. Weber between October 11th and 15th, 1891.

Although nearly 10 years have elapsed since the date of the classic Lauffen-Frankfort experiments, this project, as *un fait accompli*, still holds the record measured by distance (although the author's project from the Derbyshire coalfields to the metropolis is 120 miles in length). Nevertheless the progress in long-distance transmission work in the years that have intervened, is remarkable, not only by reason of the enormous power potentials transmitted, but also because of the ascending gradient of the electrical pressures established on the transmission lines; in one instance the pressure of the line energy is no less than 40,000 volts.

* This pioneer project was described in a paper delivered in November, 1892, before the Manchester Association of Engineers and more recently in December, 1894, in the *Nineteenth Century*.

No one will dispute the statement that the electric agent for long-distance power transmission work has completely outpaced its rivals—strangely enough, on the very day of the discussion of Mr. Sturgeon's paper on "Pneumatic Power Transmission," in 1889,* the author received from Bâle a letter written to him by Mr. C. Brown, giving the results of the electric energy transmission installation at Schaffhausen—the results, giving some 70 per cent. efficiency at the end of the line some eight miles long, were read by the author during the discussion referred to, and probably everyone there realised the complete eclipse of the pneumatic agent of power transmission even for comparatively short distances of five miles.

Although the author's pioneer project described at Manchester in 1892 has not, *per se*, so far received the honour of practical application in England, the pioneer efforts have not by any means proved fruitless, and probably one could find few parallels to the remarkable spread of the conviction of the great economic value of the principle of concentration of the generating energy in coalfield centres, and its distribution to industrial and populous centres at high pressure, a conviction that is symbolised in the public message of the Parliamentary Committee formed last year, 1900, to report on the Power Bills sent up to the House of Commons. This message, formulated by a body of serious Englishmen, read as follows :—

"That the value of electrical energy as a means for the transmission and application of power has been amply demonstrated, and its importance to the industries of this country is admitted. The Committee accordingly advise that it is of public advantage to facilitate measures which may ensure a general supply of electrical power to all consumers who may seek to avail themselves of the economy and efficiency offered in the service of these sources of application of power."

The author's coalfield generating project was brought before Mr. Klimké, State mining engineer to the late South African Republic, and eventually a modified application of such a project was put into practice on the Rand—a steam-power electric generating station was erected at Brakpan.

This installation constitutes the pioneer example in actual practice of electric power transmission—a project that, but for the outbreak of the war, would have established by this a precedent of high financial success.

In the author's 1892 project, the thermodynamic feature of the electric scheme included as desirable factors the following :—

1. The establishment of a generating plant that should be as nearly as possible independent of labour. (This involved the mechanical transportation of the coal to the generators and the mechanical removal of the incombustible residue.)
2. The conversion of the solid fuel into a combustible gas of sufficient calorific uniformity to drive with sufficient steadiness a gas-engine-driven alternator of 300 H.P.
3. The recovery of the nitrogen (as ammonia) and the tar compounds from the fuel.
4. The transmission of the dynamic energy directly to the armatures of alternating machines.
5. The power units to be so arranged that the gas engines could always be worked at full load.

All the three actual and responsible specifications published in the author's paper in 1892 included the elevation of the line energy to a pressure of 20,000 volts. One only included as the electric energy source the use of direct current generators. Another included as the electric energy source the use of biphase alternators, and the third included a triphasic alternator.

The evolution of the electro-technics of long-distance transmission during the last ten years, although exhibiting nothing of a strikingly revolutionary character, is, nevertheless, pregnant with interest.

To point the finger in the direction of the trend of modern practice is to indicate the survival of the best methods and apparatus ; to do more than this in the limits of the present article is impossible.

The last ten years' period of the practical evolution of the science of long-distance electric power transmission has, fortunately, provided data that will permit the drawing up of a specification of such ample anticipation for all emergencies that a pre-determined sustained terminal efficiency at the customers' motors can be guaranteed.* The precedents of what should be avoided in formulating a specification are negative riches bequeathed by the pioneers in the old to the workers in the new century. The latter tread on safe ground, and they can thus move with confidence. What they will accomplish is far beyond the power of the most brilliant imagination to foretell. The almost terror inspired by the mere suggestion of line pressures of 20,000 volts has quite disappeared. The bogeys of insulation, climate, inductance, and capacity difficulties have been levelled by the effect of absolute experience.

As the pressures are leaping in startling bounds from 5,000 to 10,000, 20,000, and now even 40,000 volts, the magnitude of the power capacities of electric generating machines is increasing, and 5,000 KW. units are likely to become the usual units of large electric power supply stations.

With the boldness of enterprise so characteristic of our cousins in the Far West, they have already established commercial installations of power transmission in which the pressure on the line is 40,000 volts—and the mere list of pressures of the electric power transmission projects already in regular operation, is a splendid testimony to the alertness and receptiveness of the value of patent facts of a great science—born of our illustrious Faraday, of immortal memory.

(To be continued.)

* Paper read before the Liverpool Engineering Society, 1889.

* The specifications of the 1892 project are to be reproduced in the appendices to this article, also with remarks by Mr. C. E. L. Brown.

A NOTE ON WIRES.

By ROLLO APPLEYARD.

In the days before electricians had pocket-books, and when the cable engineer was content with his "Clark & Sabine," it was the custom to look to the Electrical Review for additional rules and handy formulæ. The electrician of to-day finds all his wire work ready accomplished for him, and if only he restricts himself to standard gauges, he can tell from a glance at his tables the corresponding diameters, weights, resistances, and safe currents for all practical purposes. Similarly, the cable engineer, knowing the specific qualities of his materials, can determine at once the data for the dielectric of any given standard size of core. If the gauges are out sizes, it is still a comparatively easy matter for him to calculate the required relative weights and electrical values for a definite case, and if he is wise he keeps a special note-book for facilitating the work on such occasions. Here is a note which he may care to enter with the others :—

Suppose it is required to know the *change* in weight of the conductor, or the *change* in weight of the dielectric of a cable core, corresponding to a change of 1 mil in the diameter of either of them. If the diameter happens to be a standard gauge, the change can, of course, be estimated at once from the tables; but if the gauges are not on the tables, the ordinary arithmetical method of finding the increment of weight is somewhat lengthy ; it is also unnecessary. It is of the utmost importance to manufacturers of wire, and to manufacturers of cylindrical goods generally, to be able to state quickly the additional weight of material added in any process, by an error of 1 mil in a die or a draw-plate. An obvious method for determining this change per mil is to co-ordinate diameters against weights, in a curve, for, say, copper, gutta-percha, india-rubber, or for any given material. From this curve, the change in weight per mil can be measured, but the method is rather laborious. Such a curve is shown in the figure for the case of copper.

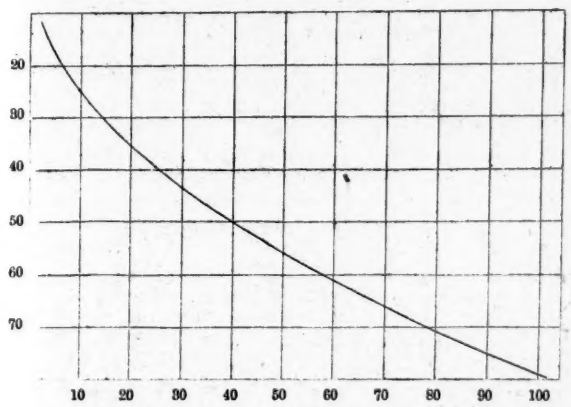
Fortunately, this labour can be avoided by noting that since the weight is proportional to the square of the diameter, the curve is necessarily a parabola, and that the rate of change in weight at any point represented on it, is

the tangent to the curve at that point. To evaluate it, let w be the weight in pounds corresponding to unit length of a cylinder of diameter d, then $m\,w = d^2$, where m is a constant for the material, corresponding to the particular length of it chosen as the unit. The tangent to the parabola ($m\,w = d^2$) is found at once by differentiation to be $2\,d/m$. If then, d_1, d_2, are any two diameters very near to one another, and w_1, w_2 are the corresponding relative weights, the tangent to the curve at that part of it is

$$\frac{w_1 - w_2}{d_1 - d_2} = \frac{2\,d_1}{m}$$

If the change in diameter is only 1 mil, $d_1 - d_2 = 1$, and the corresponding change in weight at any diameter, d, is given by $w_1 - w_2 = 2\,d/m$

We have, therefore, only to find the value of the constant $2/m$, and by direct multiplication with d, we have at once the required change of weight per mil for any value of d. This figure we may call the "mil-constant," and it is obvious that if it is known for any one substance, the mil-constant for any other substance is found at once by multiplying by the ratio of the densities. The arithmetic is



extremely simple, but a few general cases may be here tabulated for reference. The weight w, in lbs., of a yard length of material whose density is Δ, and whose cross-section is a square inches, is $1{\cdot}3017\,a\,\Delta$; or if the section is circular, and of diameter d inches, the weight in lbs. per yard length is $w = 1{\cdot}0223\,d^2\,\Delta$, and by our definition, $m\,w = d^2$; hence, the required constant $2/m$ is $(2{\cdot}0446\,\Delta\,10^{-6})$ per yard. In the following table, the mil-constants are given for certain materials used in cables :—

Table of Mil-Constants.

——	Density.	St. mile.	N.M.
Gutta-percha ...	1	0·00360	0·00415
Copper	8·9	0·03206	0·03696
India-rubber ...	1·3	0·00468	0·00540
Iron	7·8	0·02809	0·03239
Brass	8·4	0·03026	0·03488

To use this table, multiply the diameter expressed in mils by the mil-constant corresponding to the material and to the unit of length ; the result is in lbs. Suppose, for example, that there is an error of manufacture causing a difference of 1 mil in a gutta-percha core of diameter 400 mils ; the difference in weight is $400 \times 0{\cdot}00415 = 1{\cdot}66$ lbs. per n.m., the value of which may be anything up to 30s.

In a similar manner, an expression might be found for the change in resistance corresponding to a 1 mil change of diameter ; for the resistance being proportional to the reciprocal of the weight, the original equation above, may be written

$$\frac{1}{r_1} - \frac{1}{r_2} = \frac{2\,d}{n},$$

where n is a new constant ; the result is a conductivity, and its reciprocal gives the required change in resistance. This latter result might perhaps be useful in conductivity tests on a large number of samples of approximately the same gauge ; in which case a mil-constant for conductivity could be found, and could be applied as a correction to the bridge test.

CURRENT SPECIFICATIONS.

LI.—EASTBOURNE EXTENSIONS.

Summary.

Extent of Contract.—Section F.—Supply of transformers and fitting up of transformer sub-stations. Section G.—Supply of underground mains, conduits, and road work for private and public lighting. Section H.—Supply and erection of arc lamps and posts.

Number and Capacity of Transformers required.—Three of 10 kw., one of 15 kw., 17 of 30 kw., and three of 40 kw. capacity.

Type of Transformers.—Nine of the transformers to be placed in transformer street boxes, each capable of holding one 30-kw. transformer, the remainder to be placed in sub-stations.

Transforming Ratio.—All transformers to be wound for 2,200 volts primary voltage, and 200 volts secondary voltage, and to be suitable for use on a 50 ~ circuit.

Pressure Test between Primary and Secondary Coils, and between Coils, Core and Frame.—5,000 volts alternating applied 30 minutes.

Permissible Temperature Rise after Six Hours' Full Load run.—45° F.

Guarantees.—As to efficiency at various loads, and magnetising watts to be stated in tender.

Type of Street Box.—To be suitable for burying direct in the ground with separate compartments for high and low tension switch gear.

Type of Sub-station.—To be of either cast-iron or brick, each to be capable of holding four 40-kw. transformers, together with the necessary bus bars and high and low tension switch gear. All switch boxes and sub-stations to be placed in positions shown on plan issued with specification.

Cable Contract.—A complete system of high tension cables and alterations and additions to the existing low tension distributing network, all as shown on plan.

Type of Feeder Cables.—To be approved by engineer. High tension feeders to be concentric and laid in a stoneware or other approved trough run in solid with an approved compound.

Type of Low Tension Distributors.—Concentric lead-sheathed cables, partly laid in solid troughing run in solid as above, partly drawn into existing pipes and conduits. Arc lighting cables to be twin, lead-sheathed and armoured.

Quantities of Cables Required.—To be as per schedule issued with tender.

Number of Arc Lamps.—Sixty-one 15 ampere alternating current single-carbon arc lamps, to burn not less than 16 hours without retrimming.

Method of Burning.—To be connected singly through separate 200-volt transformers to the network.

Type of Posts.—Alternative designs to be submitted to meet specification requirements.

Dates of Completion.—To be filled in by tenderers for each section.

Penalty for Late Completion.—*One per cent.* per week for each section completed later than specified date.

Terms of Payment.—80 per cent. on engineer's certificate during progress, 10 per cent. on completion, 10 per cent. 12 months later.

Period of Maintenance.—Sections F and H, 12 months from date of completion ; Section G (cables), three years from date of completion.

Stipulations as to Removal of Foreman.—Satisfactory.

Stipulations as to Wages paid to Workmen.—None.

Amount of Sureties demanded.—20 per cent. of tendered sum.

Arbitration Proposals.—Satisfactory.

Date for Receipt of Tenders.—March 4th, 1901.

This specification is signed by Mr. W. C. C. Hawtayne, the consulting electrical engineer, and Mr. J. K. Brydges, the borough electrical engineer to the Corporation. It deals with the outside work required in connection with the extension scheme adopted some time ago by the Council. From a technical point of view the specification is thoroughly satisfactory, the only noticeable feature being the very low temperature rise above surrounding atmosphere specified for the transformers after a six hours' full load run, viz., 45° F.

The general conditions have been drawn up with a view to meet contractor's just requirements. True, three years' free maintenance is demanded for the cables from the date of completion of the contract, and this is not likely to find acceptance with cable manufacturers ; but, on the other hand, there are no vexatious stipulations as to dismissal of workmen, or other labour conditions.

The arbitration clause is worded in compliance with the phrasing adopted by the Municipal Electrical Association and the Electrical Plant Manufacturers' Association, and an additional safeguard to tenderers is given in the invitation to name for each section the date on which they are willing that penalties shall commence if the work is not completed.

REVIEWS.

American Telephone Practice. By Kempster B. Miller. New York: *American Electrician* Company, 120, Liberty Street.

(*Concluded from page* 313.)

Chapter XXXI. is devoted to overhead cable construction. Here, again, Mr. Miller is unfortunate in his reference to Europe. He remarks that "in the *early* days of telephony, rubber was considered the best insulating material for wires in overhead cables"; so far true! But when he goes on to attribute the *extensive* use of such cables at the present day to the British Post Office, he is displaying his entire ignorance of modern practice in this country.

Fig. 313, which purports to show a cable prepared for splicing, might easily be taken for an illustration of a wire brush. If, dispensing with this figure, he had in substitution shown the different layers separately and tied, he would have filled the space with advantage.

Is Mr. Miller aware that the method of drying a joint in a paper cable by "boiling out" is antiquated?

Useful information is given at the close of this chapter touching pothead and other methods of terminating aërial cables, and of making a junction between cables and open wires.

Chapter XXXII. deals with underground work in a brief summary of 13 pages, a part which is all the more disappointing because what information is given is interesting, but far short of what might profitably have been written. There is a brief description of single and multiple duct laying, but not a word on pipe work, or on the method of distributing from the main duct lines. In this chapter the method of drawing in the paper-insulated cables is described—briefly, it is true—and in the next chapter information is given as to the methods of testing these cables. Where do we find a description of the cables? Does he intend the meagre reference made to the antiquated dry-core cables for over-house work to apply to the underground cables?

Chapter XXXIII., on "Testing," contains nothing that is new. The rough-and-ready factory methods of locating faults in a cable are described, then follow disquisitions—not very able ones—on the more refined methods of testing for conductor resistance, insulation and capacity by means of the Wheatstone bridge and the Thomson and d'Arsonval galvanometers. The author, in his preface, says he had made no attempt to treat the subject from its purely mathematical standpoint, and he certainly avoids mathematics throughout the work, save, unfortunately, in this chapter. It would be well if Mr. Miller confined himself to the description of the methods of testing, and left the description of the testing apparatus to works on testing.

Chapters XXXIV., XXXV. and XXXVI. are three new chapters introduced into the third edition. Chapter XXXIV. is an interesting one, devoted to the development of automatic exchanges—a phase of telephone work which, though alluring to the telephone engineer, does not hold out much hope of a practical result. It appears to be a case of replacing comparatively cheap and reliable operating labour by an expensive and not too reliable mechanism requiring skilled attendants. Chapter XXXV. deals in a practical manner with storage batteries.

The author in his preface to the third edition says the specifications contained in Chapter XXXVI. are given "as a help rather than as an inflexible guide to those drawing specifications." Those furnished certainly lack details, but they contain some good matter, and should be useful to young telephone engineers as suggesting the lines on which to work in estimating for a complete exchange equipment.

This closes the review, and although we have had occasion to remark on certain omissions, we will now devote a few paragraphs to pointing out other omissions of an important character, and to offer some suggestions for future editions.

The work is silent, for instance, in respect of meters. This is all the more regrettable, as many types, more or less unsatisfactory it is true, are now in use in the United States.

It is also remarkable that the "call-wire" system, which had its birth in New York, is not mentioned. Can it be that a system which is still in use to some extent in this country, has ceased to be within the range of practical telephony in the land of its inception! Even it be so, a historical paragraph giving a reason for its disuse would have been interesting.

Long-distance speaking has been developed more in the United States than in any other country, yet in this work there is an entire absence of information on the subject of long-distance toll lines. The manner in which telegraphy and telephony are simultaneously utilised in the working of those lines in America is certainly worthy of description; whilst the method of working junction lines (or trunks, as they are called in the States) deserves a place in the pages of such a work as that of Mr. Miller.

Underground work generally deserves more notice than it has received, especially the comparative advantages and cost of single and multiple duct work, which are both practised in America.

In order to permit of more detailed information on certain portions of the subject already touched upon, and of the inclusion of other parts not yet embraced by the work, without increasing the dimensions of the book, we would suggest that in future editions there should be less blank space in its pages—more than half the area of each page is at present margin. Some of the photographs given, which serve no practical purpose, might with advantage be deleted. Take a few examples:—In fig. 242, if it were not for the title, only those familiar with the distributing board represented would recognise it, and yet this photograph occupies a full page. Figs. 240 and 241, which are reproductions of photographs of the horizontal and vertical sides of the same board, occupy almost an entire page apiece, but two small section plans would be more instructive and would occupy less space. Again, figs. 287, 288, and 289 are devoted to illustrating very old methods of raising a telegraph pole, and the photographs are more suited to the pages of a popular magazine than to those of a technical work.

Another class of photograph which might very well be dispensed with in this work, except, perhaps, as a frontispiece, is that of switchboards.

In justice to the author, we should add that there are some exceptions to our strictures on photographs, but generally, it may be said that, save to those to whom the apparatus and methods illustrated are familiar, the photographs convey but little information. Much discrimination should characterise their selection for a practical work.

There is an excellent table of contents in which one can quickly locate the whereabouts of a given topic within a few pages; but it takes some little time to put one's finger on what is required, even when those pages are found. This suggests the desirability of distinctive headlines to the first paragraph of each branch of a subject.

With all its faults of commission and omission, we regard Mr. Miller's work as a valuable contribution to the literature on the telephone, and cordially recommend its study to all who seek information concerning the latest phases of a progressive science.

THE BELLEVILLE BOILER.

It is desirable that, in the present parlous state of the Navy and general discontent of its engineers, the public should seek to know all it can about naval matters. Some may think we have spoken too strongly about the Belleville boiler in principle and design. We would ask all such to inform themselves to the best of their ability as to the construction of the boiler. A model of it is to be seen at South Kensington at the Patents Museum. From it can be well seen how the many folded tubes are arranged. Their flat angle can be seen, and their anomalous downcomers and other arrangements. We think no engineer could inspect the model and not go away without an added sense of insecurity when he reflects how some 62 of our newest ships are fitted with it. The model appears to have been placed at South Kensington when so many people who should have known better were overflowing with praise of the boiler, evidently quite unaware

of the army of men who were employed to pull the boilers through their tests on the big cruisers.

We should point out that the supposed water level in the Belleville boiler is about two-thirds up the height of the tubes. The upper third of the manifolds is thus supposed to act as a drier or as a superheater. At the same time the boiler is supposed to have a rapid circulation, and means are provided to return water from the upper or steam drum to the lower water box whence spring the various elements of tubes. No doubt these return pipes are needed, for we fully believe that from time to time the water from the elements is projected into the steam drum, and the elements are completely dry. But with mingled steam and water entering the steam drum it is impossible that the steam can be other than saturated. The upper part of the elements does not, in fact, serve as a steam dryer, save and except when the tubes have blown themselves dry, that is to say, at such times *only* as the tubes are becoming dangerously overheated above the fire. An inspection of the model at South Kensington will serve to explain why it is that the lowest row of tubes is found to bend upward and buckle when at work, a fault that occurs in the boilers of the ships of the Messageries Maritimes, and that has occurred in many other ships, notably the ss. *Kherson*. If it be pictured to the mind that our naval boilers have proved most wasteful of fuel except when fitted with an economiser on top of the present boiler, and that this appliance is very like another but smaller boiler put on top of the model, our readers will begin to see that the boilers of our ships of war must be very complicated affairs indeed, so much so that the economiser is supposed, we believe, to be put out of use during an action. That is to say, just when a ship is most hardly pressed she must cut down her boiler efficiency by one-third.

Mr. B. H. Thwaite has long been an advocate for small tube boilers of water-tube type, and is so anxious to see them succeed that in his articles in the *Engineering Magazine*, he is almost excessively severe upon the large tube type, which has incurred such odium because of the bad behaviour of the Belleville boiler. The writer is by no means a strong believer in the desirableness of any large water-tube boiler, but can hardly allow the justice of condemning the large tube type because it pleased Mr Belleville to fasten upon that type of boiler as the groundwork for his designs. Mr. Thwaite now deals with the question of feed regulators and steam separators as aids to those in charge of securing "steady and satisfactory work from the boilers without overtaxing steam in their management." With this object there are illustrated the baffle devices of Niclausse, Du Temple and others, which have for their object the securing of dry steam from the foam which is delivered by the tubes. The various devices exhibit considerable complication and some ingenuity. They are generally based more or less on the inertia principle. Much, of course, depends on the tubes being free, or drowned at their outlet ends. We confess that the free-end tube seems to us best calculated to give good results, but the drowned straight tube of Yarrow's boiler has undoubted superiority in such points as cleaning and construction. In another type of separator the apparatus is placed in the steam pipe, and there is an automatic float which lifts as the water receptacle becomes filled, and allows the water to flow back to the boiler. Mr. Thwaite emphasises the importance of keeping steam dry, instancing his own system of drying, which consists in heated oil or glycerine circulated through coils placed inside receivers, steam pipes, or used in jackets.

Automatic water regulators, as adopted by Thorneycroft, are dependent upon the action of a float, which is placed in the steam drum, and opens or closes the feed valve according as the water level falls or rises. In Yarrow's device, which is most ingenious, the feed pump is driven by air or by water, according as the water level is high or low. Obviously, when driven by water, the pump runs slowly, and is thus nearly self-regulating. But on principle, Yarrow objects to automatic feed regulation, as liable to introduce danger. Generally, description of the accessories of water-tube boilers helps to emphasise the general impression of these boilers as tricky, and more or less unreliable. Mr. Thwaite omits reference to the smoke question, which we think important. Most water-tube boilers smoke badly, having no provision for combustion prior to the cooling down of the gases by the tubes. In the Weir boiler, however, the furnace is arranged with refractory walls, and there is a combustion chamber similarly protected. Combustion is first secured, and then the heat generated is absorbed by many small tubes. We draw attention particularly to this boiler, because it embodies that principle of a refractory furnace which we have steadily advocated as essential for the proper smokeless combustion of bituminous coals.

THE WIRE ACCIDENT AT LIVERPOOL.

The adjourned inquest into the deaths caused by the fall of electric wires on February 4th was opened before Mr. T. E. Sampson, in the Coroner's Court, Liverpool, on Wednesday last week. Mr. E. W. Pierce appeared for the Liverpool Corporation, and Mr. Mattinson, K.C., instructed by Messrs. Bateson, represented the National Telephone Company; Mr. Quilliam and Mr. Nield appeared for the relatives of the deceased.

Mr. Pierce stated the position of the Corporation, and reviewed the circumstances under which, after acquiring the tramways in 1897, they had taken steps to ascertain the most suitable system of traction, and, after careful consideration, adopted the overhead trolley system as that best suited to the city. There was a guard wire and guard strip over the trolley wire. On the night of February 4th there was a very exceptional snowstorm. The B. of T. had certified the particular part of the tramway on January 21st, and the accident occurred on February 4th.

Police and rescue evidence having been given,

Dr. Arkle, of the Royal Infirmary, deposed to examining the dead body of Singleton at the Infirmary. He made a post-mortem examination on February 7th. The clothes next the body exhibited pale blue-green stains, which he attributed to a deposit of sulphate of copper. There were numerous scars on the body, legs, and arms. Most of the scars were due to burns. He said that the man died from shock to the nervous system due to electricity.

Dr. Peet, of the medical staff of Brownlow Hill Parish Hospital, deposed as to the condition of the deceased man, Hankey, when he arrived at the hospital. On the back there was a large patch about the size of the palm of the hand, and in the centre of this the skin was raised and torn into strips. There were two smaller patches across the upper parts of the calves of the legs, and some green discoloration. Above the right ankle there were two deeply furrowed marks about the size of a thick wire, the marks being charred. The cause of death was electric shock.

Prof. Paul gave it as his opinion that death was due to exhaustion consequent upon an electric shock which caused general electrisation.

Mr. Thomas Davies, civil engineer, Liverpool, who, at the request of the coroner, had made certain investigations, produced a chart showing how the wires were carried in Pembroke Place and Gill Street, and described the arrangement. The span was about 350 ft., which was alleged to have fallen across the wires in London Road. He understood that the average span was about 80 yds. There were spans in the city of greater length than 350 ft. From the standard in Pembroke Court to the standard on the other side of Pembroke Place was a distance of 362 ft. A portion of that span fell on the 7th ult. There were 98 wires on that standard, and of those 47 came down.

The Coroner: Was that standard sufficient itself to carry the 98 wires?—Witness: Yes. The breaking strain of the wire which he took from Singleton's body was 161·5 lbs. An ordinary strain was 200 lbs. The maximum strain to which the wire was subjected by stretching into position was about 50 lbs., so that an extra strain of 109 lbs. was introduced in some form before the wire broke. The most likely form was the weight of ice clinging to the wire and the force exerted by the wind. At 7 o'clock in the evening the force was 33°, and at 8 o'clock 31°. The wire was of the customary weight of the wire used. It was advisable that drivers, guards and police should be instructed as to the proper place where the current could be cut off and the proper mode of doing it. It was desirable that they should be provided with rubber gloves, and if overhead wires were still to be used, nippers for cutting the wires should be supplied. By Mr. Mattinson—Witness could not suggest any stronger wire than that used by the telephone company. It was a phosphor bronze wire, which had a breaking strain of 45 tons. Copper was next strongest, and had a breaking strain of 35 tons. The life of a wire depended on climate and other conditions, but on an average would be about seven years. By Mr. Pierce: Two kinds of guards were available, the overhead wire guard, and the form of guard used in Liverpool. Both were unsatisfactory, but of the two he would prefer the wooden guard. Assuming the Corporation had decided to maintain the trolley system, the proper course was to have had the telephone wires laid underground, and do away with all overhead wires but the trolley wires. By Mr. Quilliam: Assuming that they could not put them underground, there would be less danger of them falling if they made the spans less.

Mr. Wm. Lamb, linesman, deposed that the guard slip was in good order in Pembroke Place, but the telephone wires got coiled round it, and he had difficulty in getting them away. Owing to the force he had to use, the slip might have got displaced.

Mr. Mattinson, for the National Telephone Company, said it seemed clear that the two men were killed by electrical shock communicated by the telephone wires. The trolley wires were placed in the streets under statutory authority; the telephone wires were also placed there by statutory authority. The Telephone Company were, however, anxious to get rid of the overhead wires as soon as possible. All the main wires were underground, the overhead wires being distributive wires. During the past 12 months the company had placed 1,600 or 1,700 wires underground. In this particular case they had substituted cables for wires.

Mr. Dane Sinclair, engineer-in-chief to the National Telephone Company, questioned by Mr. Mattinson, stated that the wire the company used was tested to a breaking strain of 200 lbs. It was phosphor bronze wire, the strongest wire, which was universally used. The tension weight of a span of 100 yds. on each of the wires should be 22½ lbs. The margin of safety was something enormous. He thought the age of a telephone wire of the class at the place of the accident should be 10 years. There was nothing to indicate that the wire which came down was wanting in strength.

By the Coroner:—At the time the works were designed there were no trolley lines there.

Other evidence having been given on behalf of the company, the inquiry adjourned until Thursday.

On Thursday further evidence was given as to the state of the telephone poles and insulators in the vicinity the day after the occurrence.

Mr. C. E. Spagnoletti, civil engineer, and Mr. W. E. Langdon, also gave evidence as to the standards, insulators, and wires.

On behalf of the Corporation, Mr. C. R. Bellamy, general manager of the Liverpool Corporation tramways, said that after the accident he made an inspection of the site, and found the wooden guard slips in their place. It was not quite necessary to turn off the whole current. The system is divided into half-mile lengths, and 36 assistants who have keys of these section boxes could on short notice cut the current off from each half-mile section. As to the

presence of salt in the snow, they salted the tramway track, as is the usual custom during a snowstorm. He found the insulators on the telephone poles all right after the accident.

Mr. Arthur B. Holmes, electrical engineer to the Liverpool Corporation, stated that Dr. John Hopkinson advised the Corporation to adopt the wooden strip guard as a protection to the trolley wires. In witness's opinion the strip was better that the wire guard.

Neither form of protector was effectual for such a fall as took place. Really the only safe course was to carry the wires underground, and the Corporation recognised that, for since the commencement of the tramway system they had arranged with the company to place the wires underground. He did not think if any other form of protector had been employed this accident could have been avoided; it was a matter of opinion. Further questioned, witness stated that 500 volts would not give a fatal, or even dangerous, shock if the recipient of the shock was standing on dry material. The fatal results in the present case were due to the exceptional climatic conditions that prevailed.

Mr. Henry Warren, chemical expert, Liverpool, examined by Mr. Quilliam, stated that in his opinion the accident was caused entirely from insufficient insulation. It would be a small matter not only to arrange a perfect insulator against falling wires, but also to readily attach the same.

Major Philip Cardew, of London, said it was quite possible that even with the best known guard arrangement, the accident in question might still have happened. The real difficulty to fight against was the tendency of the telephone wires to twist into small coils, become springy, and insert themselves into almost anything.

If a person entangled in an electric wire could throw himself so that the live wire could touch the ground he would be relieved from the shock.

Mr. Philip Dawson, chief engineer and managing director of Messrs. R. W. Blackwell & Co., who constructed the Liverpool tramways, expressed the opinion that the wood guard strip used in Liverpool was the best method of trolley protection that could be adopted. He agreed with Mr. Holmes that 500 volts would not necessarily produce fatal results. Personally he had had any number of 500-volt shocks, and was no worse for it, although the burns were very painful.

Mr. Samuel B. Cottrell, manager and chief engineer for the Liverpool Overhead Railway, coincided with the opinions of the previous witness.

This concluded the evidence, and in summing up the Coroner expressed the opinion that no one had been guilty of criminal negligence. He urged the public under similar circumstances in future to keep their head cool, and, if possible, get hold of some dry material with which to detach the encircling wire.

The jury retired to consider their verdict, and upon returning into court the foreman said they were agreed that the two men died from electric shock, and that if the spans between the telephone wires had not been so long the accident would not have occurred.

A verdict of "Accidental death" was accordingly returned.

At a meeting of the Tramways Committee on Friday, it was stated that a sub-committee had been appointed to confer with the telephone company as to claims in respect to the recent accident. Alderman Petrie, who presided, moved an instruction to the engineers to prepare plans showing the overhead wires existing over the tramway lines, with their owners, so far as could be ascertained, and to report as to the Corporation's position with reference to those overhead wires.

The motion was adopted.

WAGES OF WIREMEN.

At Tuesday's meeting of the L.C.C. the Finance Committee stated that the Electrical Trades Union had drawn their attention to the fact that the rates of wages for wiremen in the Council's list—namely, 8½d. to 9½d. per hour—was not that in practice obtained. The union had asked that the rate might be increased to 9½d. per hour, and that the following items should be inserted in the list:—Chargemen 10½d. per hour, and assistants 7½d. per hour. After careful inquiry the Committee had come to the conclusion that the Council's list of wages and hours of labour should be amended, although no reason could be seen for the creation of a class of assistants to chargemen. The Committee therefore recommended the Council to amend (1) the rate of wages of wiremen by increasing it to from 9d. to 10d. per hour, and (2) to insert in the list that the rate of pay of chargemen should be from 10d. to 10½d. per hour, with a week of 54 hours; the pay for overtime, when worked at the request of the employer, to be time and a quarter for the first two hours, time and a half for the second two hours, and double time after four hours until starting time next day.

Mr. Dew said he would be glad if the chairman of the Committee would take back the recommendation. He thought that the question had not received the consideration which it deserved, and that some useful information should be given as regards the rates of wages paid to electrical workers.—Mr. H. Clark asked whether the Committee had consulted the employers as well as the workmen.—Mr. W. W. Bruce, chairman of the Finance Committee, stated, in reply to the last question, that the unions of employers were consulted as well as those of the men. With regard to the remarks of Mr Dew, the speaker observed that if he had any further information on the subject, the Committee would be glad to have it placed before them. He, therefore, asked for permission to withdraw the recommendation, and this was agreed to.

THE ELECTRIC LIGHTING OF THE VICTORIA EMBANKMENT.

On Saturday afternoon last week, the arc lighting installation which has been laid down by the London County Council for the lighting of the Embankment was formally opened by Mr. W. H. Dickinson, chairman of the Council, in the presence of many members of the Council and of the Councils of the City and Westminster.

The lighting of the Embankment is historically of great interest to members of the electrical profession, for it was here that the first steps towards the electric lighting of London were made so long ago as 1878. The arrangements at that date were necessarily somewhat primitive, according to modern ideas; the famous Jablochkoff candles were used, supplied with current by Gramme alternators. This system continued in operation up to Midsummer, 1884, but as the lighting was unreliable, and the Jablochkoff Company in a shaky condition, the Board of Works then allowed the agreement to lapse. From that time until last week the Embankment slumbered in the darkness shed by the old gas lamps.

No great haste has marked the Council's proceedings; as long ago as 1893 powers were obtained to carry out the present installation. Prior to that step, in 1892, the matter had been considered, and it was found that so many companies, with different systems of supply, included parts of the Embankment in their respective areas, that it was hopeless to attempt to carry out the work without a special generating station. This has been erected close by the Charing Cross station of the District Railway.

The generating plant, which has been laid down to the designs of the Council's engineer, Sir A. Binnie, consists of four direct-current dynamos, giving 70 amperes each at 500 volts at 500 revolutions per minute, made by Messrs. McClure & Whitfield, of Stockport, and driven by "Stockport" gas engines, provided with self-starting gear and duplicate ignition.

The switchboard is so arranged that any of the 15 circuits may be coupled with any of the dynamos. It is made to control the four dynamos; it also contains the necessary switch gear for a low tension motor generator for charging accumulators and for station lighting. There are 15 external circuits running from the board, controlling the several groups of lamps on the different parts of the Embankment and bridges. The distribution panels are fitted with special four-way switches, enabling any circuit to be fed from any one of the four machines. All switches and fuse blocks are separately mounted on slate slabs, surmounted on teak panels. From the main board the internal circuits are intercepted by a terminal testing board, fitted with disconnecting latches, thereby enabling any circuit to be isolated from the main board. A motor-generator is used for charging a storage battery for the lighting of the engine room, in which are also three arc lamps.

The foreman in charge of the station will reside in the upper floor; he will thus be at hand in case of fog during the day.

The total number of lamps to be erected under the present scheme is 147, of which 67 are on the parapets, and 80 on the kerbs and on Westminster Bridge. The former only are as yet installed. It was at first feared that the old gas lanterns would have to be removed, but fortunately the contractors, Messrs. The Gilbert Arc Lamp Company, suggested modifications which resulted in the retention of the design of the existing lanterns on the parapet. Instead of employing an ordinary carrier and globe for the arc lamps as proposed, they found it possible, on account of the very short length of their lamp, to make a new lantern and lamp carrier, which when fitted looks almost identically like the old lanterns; thus the disfiguring effect of the long carriers, covers, and globes on the top of the elegant parapet standards is avoided, and the whole has made a most convenient arrangement for the lamp, which is simply dropped in from the top, and is easily trimmed through doors in the globe.

The contractors were only allowed about five weeks to do this part of the contract. Opalescent glass could not be obtained in time, but the firm seem to have found an English glass, clear, with a large cutting, which seems in many ways superior, as it allows more light to pass and still gives a fair diffusion of light, whilst it does not appear to have the dirty effect so common to most of our well-known clear glass arc lanterns.

The lamps are all of the long-burning open type, the parapet lamps burning 40 hours without re-trimming, while those which are to be erected on standards along the kerb will run for 60—80 hours without attention. The parapet lamps are in series of 10, taking 6 amperes; it is said to be the first time that such small current arc lamps have been successfully used for public lighting in this manner. The kerb lamps will be of the 12-ampere type, containing 6 ft. of carbon, and are to be arranged to lower for trimming. Although such a great length of carbon is used, the lamp is only the same length as the arc lamps to which we are accustomed. The automatic cut-outs, switches, &c., used are all of the company's standard design.

The cables are paper-insulated, lead-covered and armoured, made by the St. Helens Cable Company, of Warrington; they are laid in the subway provided for such purposes under the Embankment for the parapet lamps. The lamps are arranged on alternate circuits, so that half of them can be extinguished at midnight.

It is to be hoped that the accomplishment of this long-needed improvement will lead to the diversion of some of the traffic from the more crowded thoroughfares; it is difficult to understand how we have put up with the delay in the illumination of this fine road so long and so patiently.

LEGAL.

The City of London Electric Lighting Company *v.* The Mayor and Corporation of the City of London.

Lords Justices Rigby, Vaughan Williams, and Stirling on Friday last week in the Court of Appeal, delivered a considered judgment in this case on the defendants' appeal against a declaration made by Mr. Justice Farwell in the Chancery Division on May last, that certain electric lighting contracts of which the plaintiff company were assignees, were binding upon the defendants. Three separate contracts were entered into by the Commissioners of Sewers in 1880 and 1891 for the lighting of the central, western, and eastern areas of the City, and as regarded the central and western districts at the time the contracts were made, there were certain aldermen and common councillors who were also shareholders in the Brush Electrical Engineering Company, who were the other parties to the contracts. The Commissioners of Sewers' Act of 1848, provided that if any alderman or common councillor was directly or indirectly concerned or interested in any contract for works with the Commissioners, such contracts became null and void. The case for the defendants (appellants) was that under that provision the contracts were invalid *ab initio*. The third contract was entered into when no member of the Commissioners of Sewers, or alderman, or common councillor, was a member of the contracting syndicate or company, but at some time subsequently certain shares were taken by members of the Corporation in the plaintiff company to whom the contracts had been transferred, and the suggestion was that that was sufficient to annul the contracts. Their Lordships now held that the section in question in the Act of 1848 dealt with every possible contract the Commissioners could enter into, and that for any commissioner, alderman, or common councillor to be interested, was sufficient to render a contract by the Corporation with the company null and void. They declared the two contracts entered into with the Brush Company null and void, but did not interfere with the order of the Court below in regard to the third contract. As each party had had substantial success they thought there should be no costs either of the appeal, or of the hearing in the Court below.

Electrical Undertakings Company.

Mr. Justice Bucknill, sitting with a special jury in the King's Bench Division, on Tuesday and Wednesday heard the case of Harrower *v.* Howe, which was an action for rescission of a contract to purchase shares on the ground of misrepresentation, and there was also a claim for damages for fraudulent misrepresentation. The defence was a denial that the misrepresentations were made, and that, if made, they were true. Mr. Lush appeared for the plaintiff, and Mr. Pollock for the defendant.

Mr. Lush said the plaintiff was Mr. William Robertson Harrower, an accountant, of New Broad Street, E.C., and the defendant was Mr. Alfred Herbert Howe. In September, 1899, the plaintiff had introduced to his notice some shares in the Electrical Undertakings Company, which was registered in 1897 for the purpose of dealing with certain patents which they had purchased from a Mr. Leitner for £7,500 in the form of fully paid shares. The capital of the company was only £10,000. A gentleman named Hurd saw the plaintiff and introduced him to the defendant, who, he said, had certain shares to sell. The defendant told plaintiff that Leitner held 7,000 shares, that the shares were sold when the company first came out at £10, and had since been sold at £25 and £30. It appeared from a balance-sheet that a Mr. Barham, who was practically the sole controlling agent and the only director of the company, had gone to America for the purpose of disposing of the American patent rights of the company, and he had a claim of £19,000 or £20,000 against the company. The defendant, however, told the plaintiff that this debt had been paid off; the American deal had been carried through, and close upon a million would shortly be paid to the company in consequence, and £400,000 had been deposited in a bank ready for the company to receive it. Defendant also stated that three banks at Ipswich were advancing and had advanced large sums of money on the shares, and that Messrs. Bacon & Cobbold, bankers, of Felixtowe, had recently advanced £15 each on these shares. The plaintiff made the bargain, paying £25 per share, and the certificates were transferred. About the middle of October plaintiff got a circular from the secretary of the company, calling attention to a large sum of money that would have to be raised speedily on mortgage. Plaintiff's suspicions were aroused, inquiries were made, and it turned out that not a single statement which the defendant had made was true. Mr. Barham's debt had never been paid, and the American deal had never been carried through.

The plaintiff was called, and having given evidence in support of his case, several other witnesses were called on the same side.

Mr. W. H. Franks, manager of Messrs. Bacon & Cobbold's bank at Felixtowe, denied in the course of his evidence that his bank ever advanced £15, or any sum whatever on the shares in question. On one occasion, however, they took some of the shares as collateral security for a debt, because they were the best security they could get.

Cross-examined, Witness admitted that he held a number of shares in the Electrical Undertakings Company, and at the time he purchased them, which was in May and June, 1899, he hoped the company had a good prospect before it. The average price he paid for his shares was £27 10s., and he bought most of them from the defendant, Mr. Howe.

In answer of a question put by Mr. Lush, Mr. Pollock said that for all times, material to this action, he was prepared to admit that Mr. Barham's debt had not been paid, and that the American deal had not gone through.

Mr. Pollock, in addressing the jury on behalf of the defendant, said that the case was an extremely serious one for his client, who for many years had held a good position in the City, being formerly manager of the Army and Navy Stores. The claim against his client was based on two distinct heads, and although the plaintiff was apparently afraid to rely solely upon the allegation of fraud, the case the defendant was there to fight was the charge of fraud, for which he maintained there was no foundation whatever. He (the learned counsel) had no doubt that when the jury had heard the whole of the evidence, they would have no hesitation in coming to the conclusion that whatever representations were made, the plaintiff, in fact, was induced to purchase these shares because he had looked into the state of affairs of the company, and had discovered from reports as well as attending meetings of the company, that it was likely to do well, and therefore Mr. Harrower bought the shares, which were of a speculative character, on the offchance of them increasing in value.

The hearing of the case was adjourned.

CORRESPONDENCE.

Electro-Harmonic Ladies' Night.

I should be glad if you would allow me space to protest against the action of the chairman at last Friday's concert (1) in putting to the audience a suggestion that gentlemen should be allowed to smoke, and (2) asking the ladies to vote on this.

It has been a general complaint that the Ladies' Nights are poorly attended, but if they are made into smoking concerts it is not likely that their tone or attendance will be improved. Further, was it right that the ladies, who were our guests, should have been placed in the invidious position of voting as to the deportment of their hosts? Naturally, only two or three held up their hands for or against, but the suggestion was declared carried, and it was surprising to find that then only about half-a-dozen men smoked. Surely

these gentlemen could have done without their cigars for once.

Another point I should like to mention is that, excepting the chairman, no other member of the Committee was present. Would it not add to the popularity of these concerts if some of the gentlemen whose names appear on the back of the programme would assist the chairman and the indefatigable Mr. Izard by attending sometimes.

V. Zingler.

[So far as we are aware, it has always been an understood thing, a sort of unwritten law, that smoking should not be permitted on Ladies' Nights, and we think Mr. Zingler's protest will commend itself to the majority of the members. —Eds. Elec. Rev.]

"Stopping" Loads on Energy Meters.

In connection with Prof. Ayrton's interesting remarks in your issue of last week, upon the power factor for which a Thomson-Houston energy meter stops, I should like to mention an experiment which I made some years ago on a similar point. The meter used was a Hookham one, in which the shunt circuit is highly inductive, the motor being of the rotary field type. I measured the power taken by the shunt circuit and found the power factor to be cos 48°. I then put an inductive load on the meter and gradually increased the power factor of this load until the meter stopped. The power factor of this "stopping" load was found to be cos 53°. It is interesting to notice that even in a meter of this type the power factor of a "stopping" load is not far (about 12 per cent.) from the power factor of the shunt circuit. A more careful experiment might show closer coincidence.

Albert Campbell.

London, *February 25th*, 1901.

Standardisation of Commutator Bars.

We have read with very considerable interest the letter, dealing with the above-named subject, signed by the well-known firm of Messrs. Thos. Bolton & Sons.

The importance of the matter mentioned by these able manufacturers, and endorsed by your editorial notes, at the conclusion of the letter to which we refer, must be recognised by anyone who has had the smallest experience in the building of electrical machinery, but the advantages to be obtained by the execution of such suggestions as Messrs. Bolton & Sons make, are not, in our opinion, confined to "Commutator Bars."

Dealing for the moment only with the "Commutator of a motor or dynamo," we think that it may prove interesting to your readers to mention that our experience, which is probably a unique one, has taught us that the want of standardisation in electrical machinery in Europe (which as Messrs. Bolton and Sons correctly state, we know, from visits to the various American factories, to be carried on so largely in the United States) has, in this one part of the dynamo, probably already cost the English dynamo builder so vast a sum, that we would not venture even to estimate it.

We refer not only to the expense in special bars but also in the insulation.

Mica is constantly used for this purpose of a size almost unobtainable except at a prohibitive price, and even then only with long delays in deliveries. Special micanite rings are made and used of costly patterns, and necessitating still more expensive tools to make them.

Mica and micanite segments are ordered, sometimes of a design that makes it impossible to cut them without enormous waste of material. No attention seems to be paid by many manufacturers to the fact that a $\frac{1}{2}$ in. in the length of a mica segment will often increase its cost by 50 or 100 per cent. and cause the dynamo builder endless delays in obtaining his deliveries of his material. We have, ourselves, gone over tons and tons of mica to endeavour possibly to supply a few hundred segments of a certain size, where had the manufacturer employed a size of mica $\frac{1}{4}$ in. shorter, he would have purchased his insulation at a quarter the price he paid for it.

As the commutators increase in size this question becomes more and more important.

It is quite a common occurrence for us to be asked for commutator rings or segments of patterns which entail untold loss to the engineer, though due to the want of standardisation, we are unable to offer a remedy. The question opens, even dealing only with the commutator, so wide a field of investigation, that we must not trespass further upon your valuable space in our anxiety to deal justly with it.

While we are perfectly well aware that the cost of insulation is a small item in the total cost of a dynamo, it would be interesting to endeavour to tabulate the totals of the separate items of prime cost of, say, the commutator, and with such friends as Messrs. Bolton & Sons, try to place by the side of those figures those which might account for losses in waste in cutting, cost of mould tools, &c., for the copper bars and the insulation alone.

We would venture to warrant to startle even some of the larger makers of electrical machinery.

In conclusion, we most cordially endorse your remarks, and those of Messrs. Bolton & Sons, and would beg you to kindly give publication to this letter in the hope that its contents may aid you to attain the good aim you apparently have in view, viz., of forming a committee to formulate proposals upon the whole question of standardisation. What experience or knowledge in any particular line we may possess, though possibly not always entirely to our interest to impart to others, is at all times at the service of the electrical machinery manufacturers.

Bergtheil & Young.

London, E.C.,
February 26th 1901.

P.S.—When we refer to "unique experience," it must be borne in mind that we supply almost every dynamo builder in Europe with some form of insulation.

Cooling Towers and Condensing Plants.

In your issue of the 15th inst. there appears a note with respect to the visit made by a deputation of the Edinburgh City Council, to report on various cooling tower and condensing plants at electricity stations in England.

We learn from the report that three of the towers inspected were erected by this company, and that the deputation were able to see "immense" clouds of steam issuing from these towers. Opinions may differ as to what constitutes an immense cloud of steam, and you will perhaps allow us to say that, although we have erected a large number of cooling towers in all parts of the country for all sorts of works and factories, we have never yet had any complaint, nor are we aware that our customers have had any complaint from surrounding proprietors or local authorities with respect to any nuisance being created by the vapour which escapes from these towers.

If any of your readers in any part of the country are interested in the question of cooling towers as an adjunct to condensing, and wish to satisfy themselves on this point by personal observation, we shall be glad to put them in the way of inspecting a cooling tower in operation in their own neighbourhood, when we think they will be convinced that the amount of vapour escaping is quite inconsiderable, and is carried off at such a height as to be no nuisance whatever.

We understand from some of our customers that, previous to the installation of condensing and cooling plants, complaints have been made to them by neighbouring proprietors with respect to the nuisance and noise caused by the exhaust steam discharging into the atmosphere, but that, of course, is another question.

For the **Klein Engineering Company, Limited,**
Wm. Hy. Roy, *Secretary.*

February 25th, 1901.

Presentation.—Mr. J. H. Barker, manager and engineer of the Cambridge Electric Supply Company's works, is leaving to take up a position at Newcastle-on-Tyne. The staff presented him with a silver salver last week.

THE ECONOMICAL CURRENT DENSITY FOR SMALL CONDUCTORS.

By JAMES WHITCHER.

There are not many of us but will smile at the idea of Lord Kelvin's well-known law having any application in the practical design of the average house wiring system. There are, indeed, occasional exceptional cases in which we feel, vaguely, that it ought to be taken into account; but beyond a haphazard concession or so to the sentiment, we do not, as a rule, let it trouble us much, even then. And only in the contractor's mind, fevered from its grim struggle with the mounting up of capital costs, does it command this scant attention. In the consultant mind, serenely indifferent to expenditure, except in its relation to professional commissions, there exists, apparently, no recollection whatever of the law. Judging from many specifications, it is fashionable in such circles to ignore it absolutely, though the heavens may fall in consequence—that is to say, though one ruin one's clients by the storage up of copper wealth for the coming generations of house-breakers.

It is not right or wise, that the law should be denied serious consideration in this connection, if it seem in the least degree to merit it; and to dismiss it uninvestigated is an act quite at variance with the true engineering instinct, which strives always after the best all-round efficiency, and never tires of its seeking. Not that this is the only point in our treatment of wiring problems, on which we are at variance with this instinct. We have worked so long and meekly under the dominance of fire insurance fads and professorial dicta, that even yet we are timid of developing our wiring methods on bold engineering lines; so that the industry must still seem in an unsatisfactory and unsettled state to those who, having its best interests at heart, would like to see it firmly founded on a substantial and permanent basis of sound standard systems and principles.

In the particular matter we have under discussion, we have been diverted from the truer issue by arbitrary stipulations made as to safe current densities and to pressure regulation. Now it is easy to show, that neither of these has anything like the great importance in the problem that has been artificially maintained for them. The safe current densities usually prescribed are those which are safe with a certain class of insulation and with certain methods of wiring. No hint is given that higher densities may be possible with other insulations and methods; and no practical encouragement is offered to development in this direction. Moreover, economical current densities are invariably safe current densities, except in few cases where the capital cost of conductors is very high and the cost of electrical energy extremely low.

However, it is the absurdly dignified position given to voltage drop that has been most effectively used to keep economical considerations out of sight. It is made a fetish of, and to disregard it is sacrilege. All the other needs of the case are dwarfed in comparison with this one. Ever and solemnly it is enforced upon us that the drop in pressure shall not exceed one, two or three volts at the furthest lamp, according to the regulating aspirations of the consultant, lest (presumably) we run into some terrible hidden danger, and risk the paralysis of the whole plant. It is all arrogant nonsense of course, with scarce a shadow of excuse. It cannot be shown that there is any real call for all this nicety of regulation. If the light at its minimum is satisfactory to the user he is not likely to object to the slight increase at the few lights he has to use at abnormal hours. As to the detrimental effect of the pressure variation on the life of the lamp—supposing there to be really anything in it under practical conditions, which may well be doubted—it is only the few lamps that are thus affected; and the value in lamp breakages can be easily appraised and set against the saving in capital charges secured by the reduced expenditure for conductors.

Moreover, touching upon a much more important point, the voltage drop in the wiring is by no means the only or the most serious of the sources of ill regulation existent in a complete system of electrical supply. In fact, supposing it were wiped out altogether, it is safe to say there would be no very remarkable improvement to be observed. For instance, public supply systems are allowed by the Board of Trade rules a variation of 4 per cent. above or below the declared standard pressure, or a total range of variation of 8 per cent., and there is little reason to believe the latitude is wasted. Again, where a user provides his own supply, even with a good steam plant and compound-wound dynamo, it would be idle to expect a lower range of variation than 5 per cent. under usual working conditions; and with shunt wound machines or batteries, where the personal equation of the attendant comes more into the question, one must be strangely lacking in philosophy to hope for less than 10 per cent. variation. Beside variations like these, operating as likely as not on all the lamps, a modest 2 or 3 per cent. on a few of the lamps pales into insignificance. Then why should the capital cost of wiring and mains be augmented in a vain attempt to remedy a state of affairs it can influence so little?

Of course, it may be argued that the voltage drop in the wiring is the last straw that breaks the camel's back. The moral of that is—get a bigger camel. In other words, readjust the burden of the load altogether, instead of standing by and throwing all the onus of blame on the one poor little straw, whose accident it is to be last. And anyway, in this case, the back breaking is not going to happen; the camel being no fool, and knowing well how to signify its objection to the increment of straws in ways more simple and sensible than actual suicide. To be matter-of-fact, the loss of potential in an economically designed network of wiring is not, comparatively speaking, a very serious affair, and there are no very substantial reasons for denying it the common privilege of having its dimensions decided by economical considerations, instead of being arbitrarily fixed. Of course it may be that sometimes all the errors of regulation will add, but there is no positive need or showing that they should do so as a rule. And supposing they do, where is the great good of interfering laboriously with an item which haply cannot influence the sum in any degree of muchness?

In all seriousness, we would plead with the general body of consulting electrical engineers and architects to be more careful lest their zeal for regulation lead them into foolishness. The following actual instances are surely sufficient to prove that the warning is necessary. In a scheme for the electric lighting of a group of public hospital buildings, comprising complete generating plant (gas engines, &c.), it was demanded that the potential loss at the furthest lamp should not exceed 2 per cent. at full maximum load. An absolutely duplicate service of mains and wiring was insisted upon—properly selected and laid mains are *so* apt to break down; and, to crown all, about 50 yards of looping was required on each of the two pair of longest mains, on the academic assumption that no reliable joints are possible underground. Result, the cost of mains alone for this little installation amounted to about 30s. per light averaged over the whole number. The cost for those lights served by the most costly sets of mains was about £4 per light. The density necessary in these was well below 100 amperes per square inch. To the best of the writer's recollection the voltage was 110. Now some of these mains might have been one-fourth the size without any prominent detriment to the service. And just fancy the idea of making a fuss over a variation of 2 per cent. on a system in the leading strings of a gas engine!

In another case, some ten lamps were to be served in a lodge half a mile distant from the generating plant. No extra pressure variation was allowed, the 3 per cent. or 6½ volts drop generally conceded all over the installation having to be strictly adhered to. Does it pass the understanding of our consulting engineers, that it would be better to advise oil lamps for such a case, if electric lighting is incapable of giving satisfaction with longer ranges of pressure variation than this? And then there are numerous instances of drive lights and outside lights, involving runs measured in hundreds of yards, being all heedlessly put under the general edict as regards pressure regulation, despite the fact that, these lamps being switched on together, there can be no increased risk of lamp failures, and any light variation is of no importance. Lighting of this kind is immensely convenient, but carried out on the rigid lines often advocated, it becomes a very costly luxury. One has never noticed that gas

engineers go out of their way to weight their efforts with fads of this description.

Having argued thus voluminously around the advisability of giving Lord Kelvin's law a voice in the design of electric wiring systems, some of our readers may have patience enough left to follow us in a discussion of its practical application in that field. It may be mentioned that, five years ago, the author published a paper on "The Economical Current Density for Electric Light Mains," * in which he called attention to some novel points in the application of the law in the design of public supply mains. Reference to this article may be of use to those sufficiently interested. It shows how the true economical current density is not varied by the load factor, to anything like the extent usually supposed, because of the way in which the cost of the wasted energy also is influenced by the same factor. In consequence, the important practical conclusion was arrived at, that the economical density in these mains still remained somewhere in the vicinity of 600 to 700 amperes per square inch, under widely diverse conditions. It justified, therefore, practice which electrical engineers had determined by instinct.

(To be concluded.)

BUSINESS NOTES.

Electrical Wares Exported.

Week ending Feb. 27th, 1900.		Week ending Feb. 26th, 1901.	
Adelaide	Value £86	Alexandria	Value £80
Alexandria. Teleg. cable ..	271	Bangkok	29
Amsterdam	225	Barcelona. Teleg. mat. ..	88
Bangkok	140	Bombay	420
Boca. Teleg. mat.	231	Brazil. Teleg. cable	190
Bombay	115	Calcutta	320
Bremerhaven. Teleg. cable ..	8,580	" Elec. machinery ..	3,[illegible]7
Buenos Ayres. Teleg. mat. ..	200	Cape Town	151
Calcutta	1,507	Coatzacoalcos. Teleg. mat. ..	75
" Teleg. wire	234	Colombo	22
Colombo	1·6	Durban	548
" Teleg. mat.	66	East London	15
Copenhagen. Teleg. cable ..	285	Fremantle	198
Durban	94	Gibraltar	40
East London	11	Grenada. Teleg. mat.	75
Fremantle	1,164	Hamburg	93
" Teleg. mat. ..	272	" Teleg. mat.	300
Gibraltar. Teleg. apparatus ..	20	Hong Kong	108
Gothenburg. Teleg. wire ..	2·7	Lyttleton	208
Hiphong	172	Madras	17
Halifax	10	Malta	30
Hamburg	56	Melbourne	552
" Teleg. mat.	300	Ostend	75
Hong Kong	218	Port Chalmers	58
Launceston	60	Rotterdam	19
Malta	32	Shanghai. Teleg. cable ..	48,000
Melbourne	554	Singapore	419
Mogador	44	" Teleg. cable ..	11,000
North Atlantic. Teleg. cable ..	1,380	Suez. Teleph. cable	1,500
Ostend	112	Sydney	1,058
Otago	126	" Teleg. mat.	600
Paris	89	Wellington	70
Pernambuco. Teleg. cable ..	3,000		
Port Chalmers. Telephones ..	42		
Rio Janeiro	202		
Santos	90		
Shanghai	265		
" Teleg. mat.	122		
Singapore. Teleg. mat. ..	1·0		
Sydney	525		
Trinidad	24		
Wellington. Teleg. mat. ..	481		
Total ..	£21,456	Total ..	£80,765

Foreign Goods Transhipped.

Gothenburg. Tph. apprs. Value £425 | Barbadoes. Tph. apprs. Value £40

Belgium.—La Société des Accumulateurs Tudor is the name of a company which has just been formed in Brussels, with a capital of £40,000.

Books Received.—"Model Boiler Making," by E. L. Pearce. London: Dawbarn & Ward, Limited. 6d.

"The A.B.C. of Dynamo Design," by A. H. Avery. London: Dawbarn & Ward, Limited.

"The Engineer's Year-Book for 1901," by H. R. Kempe. London Crosby Lockwood & Son. 8s.

"Fire Tests with Doors," No. 50. London: the British Fire Prevention Committee. 2s 6d.

"Handbook on Electro-Plating, &c." Birmingham: W. Canning and Co. 1901. 2s.

"Science Abstracts" for February. London: E. & F. N. Spon. 2s.

"Practical Electrical Testing in Physics and Electrical Engineering," by G. D. Aspinall Parr. London: Longmans, Green & Co. 1901. 8s. 6d.

* *Electrician*, March 27th, 1896.

"Cassier's Magazine."—We have no doubt that the arrangement which has been made by the publishers of this magazine for bringing out a "Library Edition" every month will be appreciated by some subscribers. The contents are the same as in the usual issue, but a certain number of cloth-bound copies are to be published for the convenience of those who are desirous of keeping their copies intact for future reference. With its red cloth covers and gilt lettering the volume has quite a presentable appearance, but it must not be forgotten that the price of each copy is 2s., or double that of the paper cover issue.

Catalogues and Lists.—Messrs. Estler Bros. have sent us one of their No. 2 catalogues, this being devoted to illustrations of, and a few notes regarding, Ambroin insulation for overhead trolley lines, &c. To mention line insulators of various patterns, insulated bolts, strain insulators, flexible bracket arm suspension, frogs crossovers, g.m. ears, section insulators, switch-boxes, telephone guards, line tools, improved trolley standards, lightning arresters, track drills, and so on, is sufficient to indicate the ground covered by the list, which, by the way, is neatly arranged and very fully illustrated.

The "Hornsby-Akroyd" oil engines and the Hornsby water-tube boilers are detailed in circulars just to hand from Messrs. R. Hornsby & Sons, Limited.

Messrs J. P. Hall & Sons, Limited, of Peterborough, are circulating leaflets of their compound direct-acting boiler feed pumps.

The General Electric Company, Limited, have just issued the eighth edition of their telephone (or K) catalogue, which, as is usual with their lists, is very fully illustrated, and contains a large number of diagrammatic drawings showing wiring connections. No doubt the growth of Continental competition is an incentive to so progressive a company as the G.E.C., and hence, therefore, we find several interesting and practical novelties in this new list; we also understand that despite the general increase in cost of material and labour, the prices of the older apparatus have been generally reduced, the quality remaining high as before. A great feature is made of the "Handcom" telephone, in which the automatic switch hooks or cradles are dispensed with, the whole of the necessary functions being performed by a switch in the handle of the hand-combination. This type is also developed into a comprehensive intercommunication system, the instrument lending itself to fixture in any position. The "General" intercommunication system has also been improved in that private circuits can be fitted if required. Among other novelties we notice the Magneto Intercommunication Handcom, the direct working bell-push telephones (for connecting to existing electric bell wires) and the "reply and call" system. The latter completely does away with the cumbersome plugboard for sub-station intercommunication, and substitutes a line selector instrument, whilst the telephone proper has a two-way switch for reply and call. This type is particularly neat in the "Handcom" pattern. The "Municipal" is a new type built according to Continental practice; these have already been supplied to Glasgow, Tunbridge Wells and Guernsey. A further novelty is the traction system, comprising telephones, both fixed and portable, for communicating from feeder pillars with the central station. Among telephones for special purposes we find mining, engine houses, military, police, &c. The last is a particularly neat pocket instrument in connection with the firm's police and fire calls, which are now being supplied to Walthamstow and Tottenham. An excellent system of electrically-controlled clocks is shown, also a very complete telegraphic code.

Conspiracy to Defraud.—Walter Vernon Scott and Charles Willis were recently charged at Lewes Assizes with conspiracy to defraud the Brush Electrical Engineering Company of £135, and with making false book entries. The company were installing electric light at Arundel Castle for the Duke of Norfolk, and the time sheet submitted to the company by Scott contained the name of a man who had no existence. As Willis was subject to Scott's instructions, he was acquitted. Scott was sent to gaol for nine months.

For Sale.—The Hull E.L. Committee offers for sale four Willans-Siemens D.C. steam dynamos, of which particulars are given in our advertisements to-day. The plant is to be sold purely because of changing over to higher voltage.

The sale of the electrical apparatus and stock of Mr. G. Stegmann (deed of assignment) takes place to-day. See advertisement pages.

H.M.S. "Repulse."—Certain electrical trials having passed off satisfactory on H.M.S. *Repulse*, the ship has now left Chatham Dockyard for duty.

The Nernst Lamp.—Mr. Walter M. McFarland, writing in the *Engineering Magazine*, says that the Nernst lamp seems destined to create a revolution in electric lighting, inasmuch as by means of this lamp a given amount of illumination can be secured with less than half the expenditure of current required by the best incandescent lamps. "When Mr. Westinghouse secured control of the Nernst patents for America the basic principles of the lamp were known, but it was entirely a laboratory device and anything but a commercial article. He put several of his brightest engineers and physicists, with the assistance of a corps of skilled workmen, at the problem of perfecting the details, and this has now been practically accomplished, after a large expenditure of money. The development of the Nernst lamp has gone on for a long time, has involved a very large expenditure, and if its commercial development should result in a great reward, it will have been fully earned."

Bankruptcy Proceedings.—At the Burnley Bankruptcy Court a few days ago the examination of R. Fester & W. Baker, trading as electrical engineers at Burnley and Nelson, was closed.

The examination took place at the Leeds Bankruptcy Court on Tuesday of Tom Arthur Flather, residing at 406, Meanwood Road, Leeds, and lately carrying on business at the Park Electrical Works, Speedwell Street, as an electrical engineer. The liabilities were given as £357 3s. 4d., and assets £31 13s. 7d. The cause of failure was stated to be "excessive rent charged for the hire of machinery." The receiving order was made on a creditor's petition, and there was a seizure and sale of effects under execution. The bankrupt, according to the Official Receiver, started six or seven years ago as an electrical engineer at Ebor Place, Hyde Park Road, with £600, left under his grandfather's will, and traded as Flather & Son. He moved to Speedwell Street two years ago, and in March last made a deed of assignment, with liabilities about £1,000. The trustee sold the plant for £860, and paid a dividend of 15s. in the £. The examination was adjourned.

Liquidation.—The Electro-Chemical Company (1900), Limited, resolved at meetings held on January 28th and February 21st to wind up voluntarily, with Mr. Robert Shaw as liquidator.

Institution of Junior Engineers.—The second lecture of the series on "Works Management," was delivered by Mr. A. H. Barker, Wh.Sc., B.A., B.Sc., at the Westminster Palace Hotel on February 20th. The third lecture takes place on March 7th.

A Local Electrical Journal.—A month or two ago one of our contemporaries dropped its old sub-title of the "Popular and Business Review of Electricity," and substituted therefor the "Electrical Times." Curiously enough, there has just appeared from Edinburgh the first number of an electrical paper which revives the dropped sub-title and is to be known as the *Scottish Electrician;* "A popular Business Monthly Review on Electricity." The wording is somewhat different, and cannot be said to be improved by the variations which have been introduced. The *Scottish Electrician* claims to be the "only electrical journal out of London," which is quite correct if we forget for the time being that there is such a place as America or the Continent of Europe. It is a 6d. monthly at present, but may be issued oftener when its business side develops and allows such a change to be profitably undertaken. The first number is inclined to be chatty and newsy, but there is no "Review of Reviews." One or two things indicate that in some respects the editing might have received a little more care, but, on the whole, and taking into account that the journal will make a speciality of the proceedings of the Glasgow Section of the Institution of Electrical Engineers, and will circulate Scottish electrical news among Scottish electricians without there being anything called English about it (except advertisements), it should receive a favourable reception from "local" electrical men. For the next six months there is to be a gratuitous circulation of 2,000 copies per month. We wish our new friend *Bon voyage!*

May's Automatic Fire Alarm.—Mr. May's automatic system of fire detection and announcement, which has been already described in these columns, will, we understand, pass into the hands of a company during the coming week. Some of the best known authorities in the electrical, fire brigade, and insurance domains, are mentioned in connection with it.

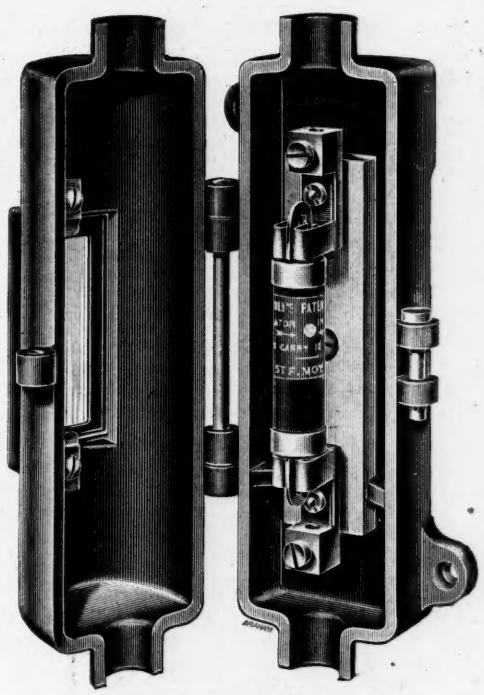
Okonite Insulating Tapes for Joints.—Ever since the introduction of high insulation rubber-insulated cables for high tension and internal wiring there has been a constant demand for a satisfactory method of insulating the conductor where it has of necessity been bared for jointing, &c. The Okonite Company, who have long been known as supplying some of the best and most durable cables for all services, have also studied this question with a satisfactory result in the form of okonite tape, which is a modification of their well-known insulating compound for jointing purposes. To secure a tubular, waterproof, high-insulation joint it is necessary to take the usual precautions of removing the rubber near the joint and having the surface of the dielectric clean and free from the fibre of the braiding, &c., the okonite tape is then wound over with half a lap until it covers the conductor, and at least 1 inch of the dielectric at each end; a little heat is then applied from a match or clear flame and the joint slightly kneaded while still warm; a second layer is then put on wound in the opposite sense and similarly treated. The joint when cooled will now have an insulation resistance equal to the body of a 600-megohm cable, and will be permanent and never show signs of the gumminess of ordinary rubber-insulated joints made with rubber solution, &c., to secure adhesion of the layers and turns. Additional layers will secure higher insulation in accordance with the grade of cable used. It is easy to demonstrate the tubular and therefore waterproof nature of such a joint by splitting it longitudinally, when, if properly made, a tape will be found consisting of diagonal short pieces of the original tape firmly jointed one to another. The question of satisfactorily insulating joints affects every person interested in the electrical industry. The central station engineer has an immense stake in the permanence of his joints; the wiring contractor has an equal stake, as much of his work is valued by the insulation tests of the wiring and the permanency of the joints.

Patent Decision.—We are informed that the case of the opposition to the German patent for Messrs. John Gibbs & Son's, of Liverpool, safety motor switches, brought by Messrs. The Elektrizitäts-Aktiengesellschaft vorm Schuckert & Co., of Nuremberg, has at length been decided in favour of Messrs. Gibbs, and letters patent finally granted. The result of this decision will, it is stated, be to considerably enhance the value of Messrs. Gibbs and Son's patents.

Peckham Trucks.—The Peckham Manufacturing Company, of New York, have issued, through their English representatives, Messrs. R. W. Blackwell & Co., Limited, a set of their 1901 calendar sheets. Each sheet has photographic illustrations of various well-known Peckham trucks.

Protection Against Lightning.—As the result of proposals brought forward by Mr. Killingworth Hedges, M.Inst.C.E., in a paper read before the Royal Institute of Naval Architects, a joint committee of that body and of the Surveyors' Institution has been formed under the name of the "Lightning Research Committee," to study disasters from lightning, especially in the case of buildings which are struck, although provided with lightning conductors. Mr. Hedges is the honorary secretary of the Committee.

Mordey's Patent Fuse.—The Mordey patent fuse, which we illustrate in a specially designed box, has been on the market for some years, and as a high tension fuse it is stated to have given great satisfaction. Up to the present the manufacturers, Messrs. Ernest F. Moy, Limited, have only made it in a somewhat expensive form, and its use has naturally been restricted to certain work in which a costly fuse was unavoidable. Now, however, as a considerable demand for the fuse for other classes of work has arisen, Messrs. Moy have, accordingly, redesigned it in a simple and cheap form, so that it may be used for any voltage up to 550 volts and in any places where a fuse is necessary, either as a main fuse in separate cast-iron boxes, as shown in the illustration, or on distribution boards. The fuse is fitted with flat metal ends, in which are



Mordey's Patent Fuse and Fuse-box.

slotted holes, enabling it to be used either in a spring clip fuseboard or on boards made to take ordinary fuse wire by milled nuts; also, there is an indicator which shows clearly if the fuse has blown. It is claimed to be particularly suitable for 500-volt power and traction work, as it can be blown with perfect safety and reliance on a dead short circuit in a metal case which is earthed. It also has the great advantage that when used in spring clips it can be replaced on a live circuit without any danger of shock. The box shown has been specially designed to take the Mordey fuse. It is suitable for use on all pressures up to 550 volts, and may be used for house services, power services, general traction work, &c. The contact terminals are mounted on a porcelain base, and the box itself, which is of cast-iron, is fitted with a hinged cover secured by sealing bolt and a glass panel for inspecting the fuse, as shown in the illustration. The box is finished in stove enamel.

Trade Announcements.—Mr. H. E. McKrell has lately joined the firm of Messrs. W. Hedges & Co. (engineering and electrical fittings makers), and the business is now being carried on under the title Hedges, McKrell & Co., at 31, Barbican, London. The firm belongs to the China Furniture and Electrical Manufacturers' Association, and manufactures Drake & Gorham's main type switches under license.

Owing to the continued increase in their battery business and in order that they may devote their whole time to it, Messrs. Pritchetts and Gold have disposed of their electrical engineering and contracting business lately carried on at 15, Hart Street, London, W.C., to Messrs. Braby & Tomlinson, Limited, who will continue it at the

same address. In future Messrs. Pritchett & Gold's only address will be Feltham, Middlesex.

The companies "S. Bergmann & Co., Aktiengesellschaft" and "Bergmann-Elektromotoren und Dynamo Werke Aktiengesellschaft," of Berlin, have amalgamated, and the combined businesses will be carried on under the title "Bergmann-Elektricitäts Werke Aktiengesellschaft," but there will be no change in the management of the undertakings.

The offices of the Electric Welding Company, Limited, have been removed from 21, Hindon Street, Pimlico, S.W., to 28, Basinghall Street, E.C., to which address all inquiries with regard to welding apparatus should be addressed. The department for jobbing work has been transferred to Messrs. Smith, Parfrey & Co., 141, Buckingham Palace Road, S.W.

Train Lighting.—Messrs. Vickers, Sons & Maxim are introducing into this country the "axle-light" system of train lighting, which is said to be much used in America. The system, which we briefly outlined some time ago, involves the use of a dynamo on each car, driven from one of the axles; the pressure is automatically regulated to 30 volts, even though the train attains speeds much higher than would suffice to give this pressure, by resistance inserted in the shunt field magnet coils. A storage battery is used to maintain the lighting when the train is at rest. The whole apparatus weighs about 1,000 lbs. per car, and the power required to drive the dynamo is said to be less than 1 H.P.

ELECTRIC LIGHT AND POWER NOTES.

Bolton.—The Corporation has been fined 10s. and costs for causing smoke nuisance from the electricity works chimney.

Brighton.—The T.C. has decided to purchase the freeholds of Nos. 18, 19, 20, Bread Street, for £759, and the surveyor is to prepare plans and specifications for the erection of the new tramway power house annexe to the present electricity works, in accordance with the dimensions and general arrangement to be furnished by the resident engineer.

The Lighting Committee submitted a report with reference to the tenders they had received for the execution of work at Southwick in connection with the new electricity works, as follows:—Concrete foundations for power house, wharf, and timber piling and timber dam and concrete weir. Five tenders were received, ranging from £35,760 to £49,650, and one firm tendered only for the concrete foundations for the power house, at £28,300. The Committee recommended that the tender of Messrs. Pedrette & Co., London, to construct the concrete foundations for the proposed power station, and to construct a wharf, timber piling, a timber dam and a concrete weir, in accordance with the several specifications for the works prepared by the borough surveyor, for the sum of £35,760, be accepted.

Burnley.—In view of the Corporation's intention to take over the tramways and apply electric traction, the electricity works are to be extended at a cost of £7,400.

Carnarvon.—There are signs of a change of feeling with respect to Mr. Peterson's proposed electric lighting and traction schemes, owing to certain facts in connection therewith having been concealed by the T.C. at the recent public meeting.

Chesterfield.—The T.C. offers a flat rate of 6d. per unit as an alternative to the charges of 7d. and 3d. on the Brighton system.

Coventry.—The City Council had before it on Tuesday an enlarged scheme for additional capital outlay upon the electric light works. A month before they had rejected a scheme involving an outlay of £18,000 in favour of a larger scheme bearing an estimated cost of £23,000. The proposed extensions included two boilers with mechanical stokers, filter, and feed pumps, one 300-KW. steam alternator and exciter, two condensers and oil separator and evaporator, switchboard panel, regulator and cables, steam exhaust, feed pipes and valves, economiser and engine, workshop tools, and building works. These were estimated to cost £14,891, additions to distributing plant, £3,000, and expenditure already incurred, principally on requirements arising out of the rapid increase of consumers, £5,009. The increase of lamp connections was 600 8-C.P. lamps per month—a rate expected to be kept up for the next two years. There were 23,000 now connected, while the plant was only capable of supplying 11,000 turned on at once. It was, therefore, obvious that the works were overloaded. Alderman Hill moved the adoption of the report, which Councillor West seconded, both urging that the extra outlay was absolutely necessary if the works were to be run at a profit. There was a long discussion, the principal opponent being Alderman Andrews, ex-chairman of the Gas Committee, who urged that the Electric Light Committee had adopted the mistaken policy of charging too little for the light. The report was ultimately adopted.

Croydon.—At the County Council meeting on Monday the Lighting and Electricity Committee reported that the extra high pressure main to Upper Norwood, laid in the autumn of 1898, specified to work at a pressure of 5,000 volts and to stand a test pressure of 10,000 volts, notwithstanding its having successfully withstood this test at the works, did not now, as laid, meet the requirements of the specification, the failure not being due to deterioration, but to the fact that such a long length of cable required larger margins of insulation to withstand the current produced by the Corporation's machines, than the makers had given it. The contractors, Messrs. Callender, had expressed their willingness to lay a new cable, in accordance with the specification from the central station to Upper Norwood, by another route, free of cost, the Corporation to pay for the excavation only and the old cable being left in the ground, the property of the Corporation. There was a discussion on this, some members expressing the opinion that the contractors should take away the old cable and replace it without cost to the Corporation. It was explained, however, that the old cable would still be used for the supply of current, and that the Corporation, therefore, would acquire it for the cost of the excavation for the new cable, and the offer of the contractors was accepted.

Dalkeith.—The T.C. last week considered a letter from Messrs. Crompton & Co., London, stating that they were prepared to carry out the arrangement of also providing lamps and maintaining them, the price per unit still to remain the same, viz., 3d. Although this was never intended by them, they consented as the result of an error in the negotiations. Bailie Chisholm and others alluded to the honourable action of Messrs. Crompton in thus giving in. Messrs. Crompton's terms were thereafter accepted for electricity supply in Dalkeith.

Derbyshire and Notts Power Scheme.—The Long Eaton U.D.C. has consented to the scheme, whilst the Ashbourne U.D.C. has decided to press for a protective clause.

Devonport.—Last week the Mayor laid the foundation stone of the Corporation electricity works, which are being erected for the joint supply of Devonport and Stonehouse, at a cost of £69,000.

Dundee.—A report was submitted to the Water Committee last week by the engineer with reference to the electrolysis of the water mains. Recently the Committee granted authority to the electrical engineer to connect the negative bar of the tramway switchboard to the water main in Lochee Road, so that it would not be necessary to provide earth plates. The water engineer reported that on inquiry he was of opinion that such connection was detrimental to the water pipes, and advised that the permission formerly given be withdrawn. The Committee agreed to withdraw the permission.

Eastbourne.—The electricity supply undertaking has realised a gross profit of £6,077 and a net profit of £834 on the past year's working. The old station is to be replaced by an entirely new electricity works, and application is to be made to the L.G.B. for leave to borrow £50,882 for that purpose. The estimates are as follows:—Buildings, £9,100; two 400-KW. steam alternators, boilers, &c., £12,800. Transformers up to 700 KW., £4,750; feeders and mains, £10,752; remodelling and extending the arc lighting, £2,600. Sixty-one additional arc lamps are to be erected.

Edinburgh.—The E.L. Committee of the T.C. last week recommended the acceptance of estimates, amounting to above £7,000, for additional machinery at the M'Donald Road electric power station.

Fulham.—On Thursday last week the Mayoress of Fulham (Mrs. Cornwall) formally switched on the electricity supply at the works, of which we gave a full account in our issue of 15th ult. Mr. F. H. Medhurst was the consulting engineer, and the General Electric Company (1900), Limited, the chief contractors.

Gillingham.—The D.C. (Chatham) has decided to accept the terms upon which the Chatham and District E.L. Company are willing to sell to the Council the New Brompton section of the company's plant.

Glasgow.—A workman while digging out a trench in Great Western Road last Saturday, penetrated an electric cable with his pick, and as there was an accumulation of gas in the neighbourhood, an explosion occurred.

Grimsby.—A portion of the town is now illuminated with 20 arc lamps, and the current is in use by private consumers. The total sum authorised to be spent for the electric light works is £55,000.

Hanley.—The municipal electricity works made a gross profit of £3,630 last year, and a net profit of £330. The salary of Mr. C. A. Cowell, electrical engineer, has been raised from £250 to £300, and that of Mr. W. Adams, chief assistant, from £150 to £175 per annum.

Haslingden.—The T.C. has been corresponding with the B. of T. with a view to getting its provisional order extended.

Huddersfield.—The surplus profit on the electricity works for last year was £110, against £2,828 in the previous year. Coal cost £1,400 more than in the previous year, and wages and salaries went up from £695 to £1,025. In addition to this, the Gas Committee had presented an account for collecting electric lighting accounts.

Hull.—Last week an accumulation of gas in one of the electric lighting ducts became ignited, blowing off the box cover in the street.

Lincoln.—An installation of electric lighting is being put in the cathedral.

Jedburgh.—At a special meeting of the Town Council last week the agreement between the Council and Messrs. Crompton & Co. for the installation of electric light in Jedburgh was signed.

Kimberley.—The borough electrician of Kimberley has been requested by the municipal authorities to prepare an estimate of the cost of adding a dozen new lights to the street lighting system, and to report on the best way of executing the work. Mr. Granville Vines has been appointed borough electrical engineer. Some complaints having been received of smoke nuisance at the street lighting station, the consulting engineer reported that to make an appreciable difference the chimneys would have to be some 40 to 50 ft. higher, and this could not be done without a large expense.

Liverpool.—The Liverpool Corporation electric supply accounts show an income for the past year of £109,814, compared with £73,562 in 1899, and a balance carried to revenue account of £47,478. The cost of coal showed a large increase, being £28,943 against £10,116 in 1899. The capital expenditure on the works has been £1,048,558.

Llanelly.—The usual notice of transfer of the U.D.C.'s electric lighting order to the Llanelly and District E.L. and Traction Company appears in the *London Gazette*.

Mansfield.—The T.C. has resolved to apply to the B. of T. for an extension of the time for the construction of works under the prov. order.

Middlesbrough.—The extensions of the electricity works recommended by Mr. Hammond are estimated to cost £35,000. The whole of the supply available is already taken up.

Mytholmroyd.—After reading a circular issued by the South Yorkshire Electric Supply Company, the D.C. has resolved to consider the whole question of electric supply.

Newcastle-on-Tyne.—A L.G.B. inquiry was held on Tuesday regarding the Council's application to borrow £10,000 for lighting certain streets by electricity. The Corporation will itself furnish the electrical energy for the purpose.

Oldham.—On Tuesday morning Mr. Bicknell, M.I.C.E., held a L.G.B. inquiry into the application of the Corporation for borrowing £157,000 for purposes of electric lighting and traction. This was the fifth application, the amount previously borrowed being £88,000. There is no more room on the present site, and it is proposed to construct a new station at Greenhill, on the other side of the railway. The demand for energy was greater than the supply, and the former was increasing rapidly. It was shown that in the first year of the electric light undertaking a loss was made of £152 8s. 5d., but afterwards a profit was made each year up to 1898, when it amounted to £1,350 19s. 7d. Owing, however, to the cost of constructing mains, &c., for supplying current, the profits had been considerably reduced for the last two years. The gross revenue in 1895 (the first year) was £915 16s. 4d., and expenditure £1,271, against £9,230 and £5,346 respectively last year. In 1895 the supply of energy was 69,000 units, and this year it had increased to 610,000 units. On October 31st this year the leases for 13 miles of existing main tramlines will expire, and the Corporation will reconstruct and equip them. At the close of the inquiry Alderman Harrop (chairman of the Electricity Committee) said the work they had to do was extensive and urgent, and he asked for early sanction.

Paddington.—The Metropolitan Electric Supply Company are seeking powers to supply electric current in Queen's Park, the newly added portion of the borough of Paddington. A Bill has been presented to Parliament with this object in view. The Borough Council, however, has decided to oppose the Bill.

Pudsey.—Messrs. Shepherd & Watney, electrical engineers, Leeds, reporting to the T.C. on the electric lighting proposals, recommend a generating plant to supply 10,000 lamps of 8 c.p., and estimate the cost at £19,552.

Rishton.—The D.C. approves of Mr. C. Chadwell's proposed application for a provisional order.

Scarborough.—An interruption of the Electric Supply Company's mains took place last week late at night. The supply was quickly restored.

South Africa.—No electric current is now obtained from the Rand Electric Central Supply Company for Johannesburg, the whole supply of current for the municipality being generated at the town lighting works. The capacity of the plant at these works being insufficient, the public were particularly requested, in a recent number of the local *Gazette*, to limit the number of lamps in use during the early hours of the evening to the smallest possible number.

Spain.—A company has just been formed in Zaragoza to establish a central electric lighting station. The water-power of the Galvez Canal will be utilised, and the electrical energy generated distributed for lighting purposes in the little towns of Rueda, Epila, Lucena, Lumpiaque, and Almunia.

A central electric lighting station has just been put in operation at Pinos Puente, near Granada. Water-power is utilised, and the electrical energy generated is being distributed for lighting and power purposes to a number of small towns in the district. The plant has a capacity of 4,000 incandescent lamps.

Sunderland.—The Lighting Committee of the Corporation has recommended the adoption of a scheme whereby nearly all the main arteries of the town will be lighted by electric arc lamps. It is proposed to erect no fewer than 82 new lamps.

Sutton (Surrey).—The electricity supply station of the Electric Power Distribution Company will not be in a sufficiently forward state for supply to be available in July as was expected, land purchase difficulties having arisen to delay matters. By the end of the year everything will be completed and supply turned on. Supply will be alternate current at 50 periods, and consumers' voltage will be 200 volts.

Wolverhampton.—Last week Lieut.-Colonel A. C. Smith, R.E., held an inquiry regarding an application by the T.C. for the sanction of the L.G.B. to borrow £58,492 for electric lighting purposes. The town clerk said that the amount asked for was classified as follows:—Building and foundations, £4,620; boiler house equipment, £18,140; engine house equipment, £19,580; feeders and mains, £15,000; and £1,602, an amount over-spent on a loan of £28,870. The machinery at present in Commercial Road had a capacity of 640 KW. With the two sets on order, together with the two sets which it was proposed to purchase, the capacity of the machinery would be brought to 2,640 KW. The demand for electric lighting in Wolverhampton had been increasing at the rate of 33 per cent. per annum. In the year ending 1899-1900 the quantity of units sold was 482,277. The Corporation had under consideration the question of electric traction on their tram lines. The item of £15,000 included extensions to the distributing system for the next two years. The total amount of loans authorised was £87,669 18s. 9d.

Yeadon.—The D.C. has resolved to support the Yorkshire Electric Power Company's scheme.

ELECTRIC TRACTION NOTES.

Bolton.—As a result of the great development of the traffic since the municipalisation of the tramways in Bolton, and their conversion from horse to electric traction, the Corporation is likely to find itself confronted with an unexpected difficulty in regard to the accommodation for the new cars it has purchased. A car shed is on the point of completion in Breightmet Street, erected at a cost of about £20,000, and about 60 cars are housed in it. Twenty-two are, however, still on order, and when these are delivered, it will be impossible to store them in the shed under present conditions. The number of cars is also likely to be increased by a town circle system, which it is proposed to inaugurate with a view to facilitate the traffic in the streets. At present the cars on almost every route make a circuit of the town before proceeding to their respective destinations, but it is proposed, by way of experiment, to start them at certain points convenient for their routes, and provide a two-minutes' service of light single-deck cars running around the central area of the town, and acting as feeders for the ordinary cars. This system will necessitate passengers changing and receiving transfer tickets, but on the other hand, it is expected, by way of compensation, to lead to more rapid services, less wear and tear of the metals in the centre of the town, and an increased earning capacity of about £6,000 per annum.

Croydon.—At the last Council meeting the chairman of the Tramways Committee was questioned as to what steps were contemplated, in view of the electrical traction system about to be installed in the borough, to guard against such a disaster as that caused at Liverpool by the breaking of overhead wires. The chairman (Alderman Sir Fredk. Edridge) said the Committee were fully alive to the importance of the question, and he had a report from the engineer to the telephone company showing the efforts which were being made to lay the telephone wires underground. The Tramways Committee proposed also to adopt guard wires, but they had not absolutely pledged themselves to any particular method, and Mr. Monkhouse, their expert adviser, had promised to make most careful inquiry.

Germany.—We read in the *Financial Times* that the official inquiry which was undertaken by the Minister of Public Works and the Minister for Home Affairs in conjunction with the police authorities and the Berlin tramway company, with a view to obviating the fatal and other accidents to passengers on the electric tramcars, and to pedestrians in general, has been concluded. As a result of the conference it is intended to introduce brakes on the cars and carry out a series of experiments with different types of brakes. The company has been requested to formulate proposals in the case of a passenger boarding the rear platform of a motor car which is hauling a trailer car, for providing the space between the car and trailer with a safety contrivance whereby it would be impossible for the passenger to fall between the two cars and be run over by the trailer. In addition to this it is suggested that the speed of the car should be somewhat reduced, especially on curves, at crossings, and where groups of children may be playing; and that strict attention should be paid to the instruction of the drivers and conductors in the fulfilment of their duties, this being regarded as a guarantee for a reduction in the number of accidents.

Some further lines of electric tramways are about to be constructed in the town of Breslau.

Lancashire.—The cost of the new street which is to be constructed under the Stalybridge, Hyde, and Dukinfield Electricity Board is estimated at £34,000. The tramways to be constructed in the same district are estimated to cost £226,884, exclusive of rolling stock. The proposed new tramways at Blackpool are estimated to cost £94,000.

Leicester.—A Special Committee of the Corporation has commissioned Mr. Manville to mature a scheme for applying electric traction to the whole of the tramways, as well as to a large extension of the present system, which has now been sanctioned. It is roughly estimated that the total expenditure on the acquisition of the present lines, and the completion of the new ones, will considerably exceed half a million sterling, if not reach three-quarters. The Committee had almost unanimously recommended the adoption of the overhead trolley system, but after the startling experience at Liverpool there is a strong revolution in feeling, and a growing determination to declare for the conduit system, though it must entail a large addition to the initial cost.

Light Railways.—The B. of T. has confirmed the following light railway orders:—Ormskirk and Southport, 1901; West Hartlepool (Deviation) 1901.

Liverpool.—Our local correspondent writes:—"On the Liverpool tramways system there are some steep gradients, notably in Fitzclarence Street, Prescot Street, Everton Valley, at the bottom of Upper Parliament Street, William Brown Street, and Islington. Up to last week no difficulty had been experienced in working up and down these gradients even with crowded cars. Fuses have often blown on the ascent, but nothing worse has happened. On Thursday of last week a heavily laden car, when ascending Everton Valley, was unable to make progress and began to move backwards. The driver applied the brakes, but still the car moved downhill and was only brought to rest when a comparatively level expanse of road had been reached. In the backward progress the trolley arm was damaged and the car had to be pushed to the Spellow Lane depôt for repairs. The passengers were naturally alarmed and had to be transferred to another car. This failure of a car to take a hill and to be checked when moving downwards, has caused some uneasiness, as there are possibilities in a failure of the kind which are not pleasant to contemplate."

Nova Scotia.—There has recently been installed in Liverpool, Nova Scotia, an electric marine railway of a novel character. A contemporary says that the electrical equipment was supplied by the Royal Electric Company of Montreal, and was installed by the Maritime Electric Company, of Halifax, N.S. The equipment consists of a 30-H.P. induction motor, the motor shaft being geared to a heavy worm shaft and wheel; the worm wheel shaft carries a pinion wheel which gears into another large wheel, on the shaft of which is placed a large heavy sprocket wheel; over this sprocket wheel the heavy 2-in. chain meshes into heavy sprocket teeth. This chain hauls the vessel up on a cradle over a track projecting out into the River Mersey to a distance of 500 ft., on a grade of ½ in. to the foot. The track and cradle are built of heavy pine timbers. The first vessel was hauled up and lowered down again on January 11th, all the apparatus and gear working well.

Paisley.—Great disappointment has been expressed on all sides in Paisley, that the scheme presented by Mr. W. M. Murphy, for the formation of an electrical tramway system for Paisley and district, should have again come to grief owing to its non-compliance with Standing Orders. The inhabitants generally are desirous that this scheme should be adopted, and the opposition of the Town Council to the measure is looked upon with disfavour.

Perth.—Last week the Council considered the question of purchasing the tramways system. Mr. Hawtayne was present to advise. It was decided to offer the company £20,000, and failing acceptance to go to arbitration.

Poland.—An electric tramway for the transport of both passengers and goods has just been completed and put in operation between Zgierz Lodz and Pabianie, a distance of about 12 miles. The line was built by the Russian Union Electrical Company, of Riga.

Portsmouth.—At a meeting of the T.C. on Tuesday, the Tramway Committee submitted a report asking for power to borrow, in accordance with the subjoined estimate:—Contract as to cars and equipments, £48,562 11s. 6d.; ditto power station plant, £29,656; ditto buildings, £10,515; land for power station, £900; contract for permanent way and underground feeders, £202,409 6s. 4d.; contract for overhead construction, £18,280; car sheds, land and buildings, special track and electrical work (estimated), £30,000; expenditure on provisional order, staff, and sundries to February 12th, 1901, £4,311 16s. 2d.; contingencies and further expenses of the staff on capital account, £17,590—£362,134 14s.: deduct amount authorised by Portsmouth Corporation Act, 1898, for reconstruction of certain parts of the line, £35,000—£327,134 14s. It was resolved that application be made to the Board of Trade for power to borrow the sum mentioned in the report.

Sheffield.—On Friday morning last some experiments were made with a view to demonstrating the adequacy of the safeguards adopted in the tramway system to prevent overhead wire accidents, such as the one at Liverpool. Mr. A. L. C. Fell, general manager, supervised the experiments.

Tramway Gauges.—In the House of Commons on 21st ult., Mr. Healy asked the President of the Board of Trade whether his department had considered the desirability of prescribing a standard gauge for electric trams in future Acts, so as to enable towns to be electrically connected in this country, as in America, without break of gauge. Mr. Gerald Balfour in reply said:—"The Board of Trade are fully aware of the importance of a uniform gauge, and when opportunity offers press their views on the subject upon promoters. I think it would be a mistake, however, to insist on the adoption of the standard gauge as an absolutely invariable rule; in hilly districts and in towns with very narrow streets it is sometimes desirable to adopt a gauge less than the usual 4 ft. 8½ in."

Underground Railways.—On Thursday last week, Mr. G. D. Perks, solicitor to the promoters of the Charing Cross, Euston, and Hampstead Railway, attended a meeting of the Hendon Ratepayers' Association, and gave some interesting details of the extensions proposed to be carried out in connection with the Charing Cross and Hampstead scheme. Two Bills had been presented to Parliament, one containing the proposed extension to Golder's Green and the tramways to Hendon and Finchley; and the other providing for an extension from Kentish Town to Highgate, with intermediate stations at "Brecknock," Highgate Hill (Archway Tavern) and Highgate Archway, and an extension from Charing Cross to Victoria, with stations at Parliament Street and Victoria Street (Stores). If these extensions were passed there would be connections with the Central London and Baker Street, and Waterloo Railways. It was proposed to run the trains on the multiple unit system, there would be a five minutes' service, and the entire journey from Golder's Green to Charing Cross would be run in about 20 minutes. With regard to the Hampstead opposition, Mr. Perks stated that the railway would only run for about 200 yards under the Heath, and that at a depth of some 200 ft., so that no possible risk would arise from drainage. The station would not be on the Heath, but on property adjacent. He reminded the meeting that the company had powers to erect a generating station at Hampstead, and if it put the powers into force, a large proportion of Old Hampstead would be swept away, so that it was to the advantage of Hampstead to get the extension passed, as in that case the generating station would, at Golder's Green, be in the parish of Hendon. Mr. Perks, in reply to questions, stated that the tramways would be worked on the overhead trolley system, the tram rails would be laid between wood blocks, and the height of the tunnels would be enlarged from 11 ft. 6 in. to 12 ft. 6 in., so that the multiple unit system being adopted, there would be no chance of vibration. The company was also prepared to supply electrical energy in bulk to the Hendon D.C. at a cost of 3d. per unit. No resolution was submitted, but there was an expression of opinion that the D.C. should give the scheme their favourable consideration and support.

TELEGRAPH AND TELEPHONE NOTES.

Anglo-German Cables.—The *Standard* Berlin correspondent says that at the recent conference of the German Postmaster-General with prominent leaders of German commerce and industry, the frequent interruptions of telegraphic intercourse between England and Germany were discussed. Almost all the gentlemen present stated that they prefer to send their telegrams to England *viâ* New York, rather than direct to London, as they then reach their destination earlier. The Postmaster-General promised to do all in his power to remedy the deficiences complained of. A considerable improvement is expected from the new Anglo-German cable which is to begin working next Spring.

Huddersfield Telephones.—Certain minutes adopted at last week's Council meeting showed that the scale of charges for the suggested municipal telephones in the borough will be for the first connection and an unlimited service in the telephone area, the charge £7 10s. per annum, and for each additional connection £7 per annum. For the message rate the charge would be £2 10s. per annum, with a fee of 1d. per call originated by the subscribers.

Manchester Telephones.—A conference was held on Thursday last week at the Salford Town Hall, attended by representatives of 17 Urban District Councils in the Manchester Telephone area, and the Corporations of Salford and Eccles. A scheme for municipalising the telephones formulated by a subcommittee was read by the Town Clerk of Salford, and with slight alterations approved by the conference. It will now be submitted to a joint meeting of the Manchester Corporation Telephone Committee for confirmation. The main principle of the scheme is that Manchester and Salford shall form a joint board, and provide the capital, Manchester having a large preponderance of representatives. Co-optive members will be elected by the Urban Councils.

Trans-African Telegraphs.—The surveying party for the African and Trans-Continental Telegraph Line arrived at Ujiji, Lake Tanganyika (German East Africa), on the 3rd ult., having partly surveyed the country from Karema. At the present moment the line has been laid for about 60 miles north of Kassanga—that is, it now runs from Kituta, at the south end of Lake Tanganyika, 80 miles up the east coast of that lake. The survey is pegged out to Karema, 150 miles north of Kituta, and the preliminary survey between Karema and Ujiji is being made. The line will then go from Ujiji round the south-east coast of the Victoria Nyanza, cross the Uganda railway, skirt the country west of Lake Rudolph, and then follow the Abyssinia frontier, and work round slightly to the

west and so to the Nile. The country between Karema and Ujiji is extremely mountainous, and in order to find a suitable route a wide extent of country must be surveyed.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
African—St. Louis (Senegal)-Bathurst	Aug. 25, 1900	
South American—Pará-Maranham	March 1, 1900	
Cayenne-Pinheiro	Nov. 26, 1900	Feb. 27, 1901
Latakia-Cyprus	June 20, 1899	
Marseilles-Barcelona	Jan. 7, 1901	
Fao-Bushire	Feb. 6, 1901	Feb. 20, 1901
Havre-Waterville	Feb. 13, 1901	Feb. 20, 1901
Landlines:—		
South American—Communication with Carthagena and Baranquilla	Dec. 8, 1900	
Chinese—Tientsin-Pekin	June 11, 1900	
Pekin-Kalgan	June 14, 1900	
Kalgan-Maimatchin	June 30, 1900	
Tientsin, *via* Shanghai	June 16, 1900	
Tientsin and Taku *via* Helampo	June 18, 1900	
Shanghai-Amoy	Jan. 18, 1901	Feb. 25, 1901
All lines connecting Cochin China with Thuanan	Oct. 23, 1900	
Communication "*via* Haneking" interrupted on Persian territory	Feb. 26, 1900	
Lines beyond Vallona, Monastir, and Elbassan	Feb. 10, 1901	Feb. 13, 1901
Saigon-Bangkok	Feb. 16, 1901	Feb. 18, 1901

Underground Wires.—The Bristol Chamber of Commerce has resolved to memorialise the Postmaster-General upon the subject of underground telegraphic and telephone wires urging their extension to all the principal cities and commercial centres in Great Britain.

CONTRACTS OPEN AND CLOSED.

OPEN.

Aberdeen.—March 15th. The E.L. Committee wants tenders for fuel economiser and Babcock & Wilcox boilers. See "Official Notices" February 15th.

Amsterdam (Holland).—April 1st. The Communal Council will on this date consider tenders for the supply and erection of all the motors necessary, and the installation of the electric lighting of the power station, switchboards, &c. Conditions from the Municipal Printing Office, 10 florins (8s. 4d.). Information from the manager of the office of Electricity, Achterburgwal, 213, Amsterdam.

Barnsley.—March 12th. The Union wants tenders for plant, &c., for the electric lighting of the workhouse. See "Official Notices" to-day.

Bournemouth.—March 2nd. The T.C. invites tenders for 42 electric cars. See "Official Notices" January 11th.

Bournemouth.—March 4th. The T.C. wants tenders for three steam dynamos, and two steam-driven surface condensers. See "Official Notices" January 18th.

Bray.—March 14th. The U.D.C. is prepared to receive tenders for Lancashire boiler and accessories, one 150-kw. high speed steam alternator, and one 25-kw. rope-driven alternator and accessories. See "Official Notices" February 15th.

Burnley.—March 23rd. The Tramways Committee wants tenders for overhead equipment for electric tramways. See "Official Notices" to-day.

Buxton.—March 12th. The U.D.C. wants tenders for a 250-kw. steam dynamo, and a Belliss engine coupled to two 43-kw. dynamos. See "Official Notices" to-day.

Cardiff.—March 18th. The Corporation wants tenders for steam, exhaust and other pipes, engine house flooring, switchboard gallery, &c., for electric tramways department. See "Official Notices" February 15th.

Clyde.—March 11th. The Trustees of the Clyde Navigation invite tenders for a 3-ton electric wharf crane for Prince's Dock. See "Official Notices" February 8th.

Eastbourne.—March 4th. The Corporation wants tenders for transformers, sub-stations and equipments; mains, conduits, &c., arc lamps and posts. See "Official Notices" February 15th.

Farnworth.—March 1st. The Council wants tenders for tramway bonds. See "Official Notices" February 22nd.

Holland.—March 25th. Tenders are being invited until March 25th next by the municipal authorities of Amsterdam, for the equipment of a central electric lighting station in the city.

Huddersfield.—March 5th. The Corporation wants tenders for motor carts for conveying coal from local collieries to the electricity works. See "Official Notices" February 22nd.

Launceston (Tasmania).—April 22nd. The Corporation wants tenders for the supply of 500 electric meters. See "Official Notices" January 11th.

Luton.—March 4th. The T.C. wants tenders for electrically lighting the Council Chamber, Town Hall, Free Library, Corn Exchange, and Baths. See "Official Notices" January 18th.

Manchester.—March 4th. The Tramways Committee wants tenders for the electrical equipment of 87 cars. See "Official Notices" February 22nd.

Newport.—March 25th. The Corporation wants tenders for steelwork, bunkers, coal conveyer, crane, steam boilers, mechanical stokers, economiser, tanks, compound condensed vertical engines, generators, condensing plant, cooling towers and feed pumps for tramway power station. See "Official Notices" to-day.

New South Wales.—March 4th. The *New South Wales Government Gazette* states that tenders will be received at the Railway Commissioners' Office, Bridge Street, Sydney, until Monday, March 4th, 1901, from persons willing to contract for the supply, delivery, and laying of about 29 miles of 6,600-volt three-core lead-sheathed cable, and of about two miles of other cables, together with the necessary troughing, filling-in compound armouring, &c.

Northfleet.—March 7th. The B.E.T. Co., on behalf of the Northfleet Electric Tramways Company, invite tenders for the construction of new tramways in Gravesend and Northfleet, and reconstruction of old lines; the supply of overhead electrical equipment; the supply and laying of cables, &c. See "Official Notices" to-day.

Roumania.—April 3rd. Tenders are again being invited until April 3rd by the municipal authorities of Ploesti, for the construction of an electric tramway in the town and the working of the same during a period of 30 years.

Shipley.—March 19th. The U.D.C. wants tenders for terminal boxes and switchgear, motors, meters, wiring, cables, wires, &c. See "Official Notices" to-day.

Southampton.—The Corporation wants tenders for insulated electric cables, frames and covers. See "Official Notices" February 22nd.

Stockport.—March 6th. The Gas and Electricity Committee wants tenders for condensing plant. See "Official Notices" February 15th.

Sunderland.—March 29th. The Corporation wants tenders for india-rubber-covered cables, stoneware casing, wrought-iron piping, and cast-iron piping, box frames and covers. See "Official Notices" to-day.

Sutton Coldfield.—March 11th. The Corporation wants tenders for house wiring. See "Official Notices" to-day.

The Hague (Holland).—March 25th. The Communal Council administration wants tenders for the supply and erection of engines and electric plant for the electric lighting of the town.

Wallasey.—March 4th. The U.D.C. wants tenders for the erection of car sheds, workshops, &c., also for extension of the electricity works (buildings and plant, including boiler, condensing plant, cooling tower, crane, engines and dynamos, cables, economisers and transformers). See two "Official Notices" January 25th.

Wallasey.—March 4th. The U.D.C. wants tenders for the overhead equipment of about 10 miles of tramways, the supply and erection of section boxes, and the bonding of rails. See "Official Notices" February 15th.

Warrington.—March 27th. The Corporation invites tenders for steel rails and permanent way work; poles, brackets, trolley wire, insulators, &c.; electric tramcars. See "Official Notices" to-day.

CLOSED.

Aberdeen.—The B.I.W. Co. has secured the contract for the electrical equipment of the Bathing Station electric tram route. This includes overhead work and cables, but not poles.

Brighton.—The Lighting Committee recently submitted a report to the T.C. in reference to the tenders for the execution of work at Southwick in connection with the new works, as follows:—Concrete foundation for power house, wharf and timber piling, and timber dam and concrete weir. Five tenders were sent in, ranging from £35,760 to £49,650, and one firm tendered only for the concrete foundations for power house at £28,300. The Committee recommended that the tender of Messrs. Pedrette & Co., London, for the sum of £35,760, be accepted. The report was received and adopted.

Brighton.—The Corporation received tenders for the supply of feeder distributor, &c., cables as follows:—

St. Helens Cable Company	£4,045 3 3
Felten & Guilleaume	4,225 3 9
Société Industrielle des Téléphones	4,332 4 10½
Land & Seekabelwerke	4,853 17 7

At a Council meeting held on February 21st, the tender of the St. Helens Company was accepted for the sum of £4,045 3s. 3d. No tenders were received from the manufacturers forming the Cable Makers' Association.

The following tenders were received for the supply and erection of the overhead equipment:—

R. W. Blackwell & Co.	£11,078 14 7
National Electric Wiring Company	11,189 10 0
Macartney McElroy & Co.	11,218 8 10½
Lowden Bros.	11,834 0 0
Hill & Co.	13,655 11 4

At a Council meeting on February 21st the tender of Messrs. R. W. Blackwell & Co. was accepted, subject to some slight modification with regard to the poles.

Hendon.—The Lighting Committee on Mr. Hammond's advice, recommended the acceptance of the following tenders, subject to the sanction of the L.G.B. to the necessary loan:—

	£ s. d.
Section A.—Boiler house plant, Holdsworth & Sons	3,283 0 0
Section B.—Engine and dynamo house plant, Mather & Platt, Ltd.	3,876 0 0
Section C.—Conden-ing apparatus and pipework	—
Section D.—Overhead travelling crane, James Spencer & Co.	330 0 0
Section E.—Switchboard and instruments, Bertram Thomas	1,221 16 0
Section F.—Accumulators, Electrical Power Storage Co., Ltd.	2,103 7 6
Section G.—Supply mains, Western Electric Co.	12,318 11 9
Section H.—Meters, British Thomson-Houston Co., Ltd.	347 15 0
Section I.—Workshop equipment, Buck & Hickman	254 4 9

A special meeting of the Council is to be held on Monday, March 11th, to decide the above.

Italy.—A contract for the supply of 102 kilometres of steel rails for the Varese and Milan electric railway, has just been placed by the Mediterranean railway authorities in Milan with the Societa Metallurgico di Savona.

Leeds.—The Leeds Steel Company is to supply 20 tons of tram rails to the Corporation at £8 per ton.

London.—The London County Council on Tuesday had under consideration tenders received in reply to advertisement for the supply of any type of water-tube boiler in successful use on a large scale in actual work. The tenders, which are for boilers to evaporate 216,000 lbs. of water per hour at the generating station to be erected at the Camberwell tramway depôt, are given below:—

	No. of boilers.	Boilers.	Stokers.	Total.
		£	£	£
Stirling Boiler Co., Ltd., Edinburgh	16	17,953	3,034	20,987
	,,	,,	4,829	22,782
B. R. Rowland & Co., Ltd., Redditch	9	21,480	5,166	26,646
R. Hornsby & Sons, Ltd., Grantham	18	26,922	1,521	28,443
	,,	27,874	3,111	30,985
	14	25,872	1,215	27,087
	,,	26,672	2,756	29,428
	10	24,627	1,666	26,293
	,,	26,310	3,390	29,700
Babcock & Wilcox, London	18	26,520	4,300	30,820
W. R Renshaw & Co., Stoke-on-Trent	14	29,418	4,000	33,418
Edwin Danks & Co., Ltd., Oldbury	12	26,995	—	—
	18	37,500	3,200	40,700

The Highways Committee stated that the tenders had been submitted to Prof. Kennedy, who observed that, as regards the alternative tender of the Stirling Boiler Company, boilers of the type specified in the tender, and almost identical with those proposed for the tramway power station, had been in use in Edinburgh for about two years, and had been thoroughly satisfactory. The output of the boilers in question had exceeded the guaranteed amount, and they had cost very little for maintenance and repairs. The consulting engineer suggested that the tender of that company should be accepted, and, having regard to his opinion, the committee recommended the Council to accept the tender of the Stirling Boiler Company, amounting to £22,782, and this was agreed to without discussion.

Newcastle-on-Tyne.—Messrs. C. A. Parsons & Co. have just secured an order from the Newcastle-upon-Tyne Electric Supply Company, Limited, for a steam turbine alternator. The plant is to be three-phase and for an output of 1,500-kw., 5,750 volts, with a periodicity of 40 complete cycles per second, and to be complete with surface condenser and air pumps driven by electric motor.

Shrewsbury.—The T.C. has accepted the tender of Messrs. Belliss & Morcom, Limited, for an engine of 350-b.h.p. at £1,260, and of Messrs. Thomas Parker, Limited, for a 240-kw. dynamo at £880.

Tynemouth.—The T.C. has resolved to accept the tenders of Messrs. Seimens Bros., for an engine and dynamo for the electric works, at £4,832, and that of Messrs. Yates & Thom, for a boiler, at £1,070. Mr. Hogg said it was satisfactory to know that they had got so many customers for electricity that it was necessary to enlarge the power station.

FORTHCOMING EVENTS.

Friday, March 1st.—At 8 p.m. Institution of Junior Engineers. Meeting at Westminster Palace Hotel. Paper on "Carburetted Water Gas," by S. Cutler.

Board of Trade inquiry in London *re* Higher pressure supply.

Saturday, March 2nd.—Institution of Electrical Engineers (Students' Section). Visit to the generation station of the London United Tramways Company at Chiswick.

At 8 p.m. Cannon Street Hotel. London Association of Foremen Engineers and Draughtsmen. Paper by Mr. E. C. Amos on "Workshop Practice at the beginning of the Twentieth Century."

Monday, March 4th.—At 7.30 p.m. The Cold Storage and Ice Association, Fishmongers' Hall. Mr. P. F. Kensett will read a paper on "Practical Insulation."

Tuesday, March 5th.—Institution of Electrical Engineers. (Students' Section). Mr. P. Laubach will read a paper on "Arc Lamps."

Thursday, March 7th.—At 8 p.m. Civil and Mechanical Engineers' Society. Meeting at Hotel Victoria, Charing Cross, when a paper on "Authoritative Rules for Unit-Stresses in Railway Girders" will be read by J. R. Bell.

At 3 p.m. Institution of Electrical Engineers (Students' Section). Visit to the Works of the Thames Iron and Shipbuilding Company, Orchard Yard, Blackwall.

At 8 p.m. Röntgen Society. Ordinary meeting at 20, Hanover Square.

At 8 p.m. Institution of Junior Engineers. Lecture at Westminster Palace Hotel on "Works Management," by A. H. Barker.

At 8 p.m. Institution of Electrical Engineers at the Institution of Civil Engineers. Extra meeting. Subject to the discussion on Mr. Madgen's paper being concluded at the meeting of February 28th, the following paper will be read (in abstract) by Mr. M. O'Gorman, member: "Insulation on Cables."

At 8 p.m. Institution of Electrical Engineers (Dublin Section), will pay a visit to the Dublin United Tramway Company's power station at Ringsend.

Saturday, March 9th.—At 3 p.m. Civil and Mechanical Engineers' Society. Visit to Kensington and Notting Hill Electric Light Works.

Wednesday, March 13th.—At 8 p.m. Institution of Electrical Engineers (Glasgow Section). Meeting at the Institution of Engineers and Shipbuilders, 207, Bath Street.

Thursday, March 14th.—At 8 p.m. Institution of Electrical Engineers. Meeting at the Institution of Civil Engineers.

Saturday, March 16th. — At 7 p.m. Institution of Junior Engineers' Annual Dinner at the Westminster Palace Hotel.

NOTES.

The Glasgow Engineering Congress.—Preliminary particulars have now been issued of the International Engineering Congress which is to be held at Glasgow from September 3rd to 6th. Lord Kelvin will be hon. president, and Mr. James Mansergh (president of the Civil Engineers) will be president. The vice-presidents include Prof. Perry, as president of the Institution of Electrical Engineers, and the presidents of a number of other engineering societies. There will be nine sections in all. Those of interest to the electrical fraternity are:—

Section I.—Railways.
Chairman, Sir Benjamin Baker, K.C.M.G., F.R.S.
Honorary Secretary, R. Elliott Cooper, 8, The Sanctuary, Westminster, London, S.W.

Section III.—Mechanical.
The Institution of Mechanical Engineers.
Chairman, William H. Maw, President of the Institution of Mechanical Engineers.
Honorary Secretary, Edgar Worthington, Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.

Section VII.—Municipal.
The Incorporated Association of Municipal and County Engineers.
Chairman, Charles H. Lowe, President of the Incorporated Association of Municipal and County Engineers.
Honorary Secretary, Thomas Cole, 11, Victoria Street, Westminster, London, S.W.

Section VIII.—Gas.
The Institution of Gas Engineers.
Chairman, George Livesey.
Honorary Secretary, J. W. Helps, Gasworks, Croydon, London.

Section IX.—Electrical.
The Institution of Electrical Engineers.
Chairman, the President of the Institution of Electrical Engineers.
Honorary Secretary, W. G. M'Millan, 28, Victoria Street, Westminster, London, S.W.

Correction.—We stated last week that Mr. P. J. Pringle was married to Miss Beryl Olive Blyth, daughter of Sir Arthur Blyth, K.C.M.G., C.B. A slight error occurred, as we should have stated grand-daughter instead of daughter.

The Lay Press Again.—Our scientific contemporary, the *Church Weekly*, in a recent issue (February 15th) has once more published the story that aluminium was discovered 1,939 years ago in the reign of Tiberius; but it unfortunately omits to mention the day, the month, and the inventor's name; while it gives no clue as to whether the metal was reduced by means of sodium, or, as we would fain hope for the honour of the electrical profession, electrolytically by means of a direct-current dynamo. This anecdote has had a merry life of three or four years, not in England only, and it has appeared in more than one paper that really ought to know better even from the technical aspect, without considering such insignificant details as language and chronology. We wonder how many of the journalists who have glibly reproduced the tale have ever consulted the *Naturalis Historia*, written by C. Plinius Secundus, to ascertain whether he, as was originally asserted, had actually said anything of the kind. If they had done so, as we have, they might have found, assuming the necessary acquaintance with latinity, that Pliny was writing about some wonderful description of flexible glass, and not about a metal at all. Besides, even a non-technical journal which presumably has to deal with questions of ancient (church) history now and again, might be expected to know that the princedom—to use the old phrase—of Tiberius had not begun 1,939 years ago; for he was then only four years old, and did not come to the throne till A.D. 14.

Power Transmission Plant.—Messrs. Ernest Scott and Mountain, Limited, have recently completed an electric power transmission plant for the Broughton and Plas Power Coal Company, Limited, near Wrexham. The plant consists of two horizontal compound engines, each developing 350 I.H.P.; two 200-unit four-pole generators driven by ropes; a main switchboard, with measuring instruments and switches; the necessary main and underground cables; two 150-H.P. electric motors for driving haulage gear; and one endless rope haulage gear for operating three roads. There is a 60-H.P. electric motor for pump driving, a three-throw pump to deliver 150 gallons per minute to a height of 800 ft., an electrically driven three-throw pump, to deliver 50 gallons per minute to a height of 125 ft., also a 5-H.P. electric motor, driving a single-barrel pump through worm gear. This is believed to be the largest electrical plant in the kingdom of endless rope haulage and pumping.

The Belleville Blunder.—The Belleville blunder was of greater proportions than we had dared to imagine, as witness the following discussion in the House of Commons last week:—

In reply to Sir J. Joicey, Mr. Arnold-Forster said the number of Belleville boilers supplied to the Royal Navy is 584. The number on order to be supplied is 1,005. The boilers have been made, or are being made, by a variety of firms, 14 in number, and in the Royal dockyards at Chatham and Devonport. I shall be happy to give the hon. member the particulars of the firms in detail if he desires it. It is not possible to give the exact total cost of the boilers, as they are in all cases ordered with the machinery, and the price is not separately stated. It will, however, be possible to give an approximate estimate of the cost of the boilers, as apart from the engines, and such a statement is being prepared. The amount of royalties paid in respect of the Belleville boilers up to the present date is £141,470.

Sir J. Joicey asked if the hon. member would supply him with the amount of royalties that would be paid on the 1,005 boilers. Mr. Arnold-Forster assented.

Other questions were asked on the general water-tube boiler question and the work of the Committee:—

Sir F. Flannery asked the Secretary to the Admiralty if it was the intention of the Admiralty to request the Water-Tube Boiler Committee to test the endurance of one of His Majesty's ships fitted with water-tube boilers by driving her at full speed for an ocean passage, say, from England to America or from England to the Suez Canal; and whether any such test had ever been made.—Mr. Arnold-Forster: It is not the intention of the Admiralty to request the Water-Tube Boiler Committee to carry out a trial such as that referred to in the question, as they prefer to leave to the Committee the initiative in asking for such trials as it considers will afford the information which it requires. I have, however, reason to believe that the Water-Tube Boiler Committee does propose to institute an ocean trial, provided that such a trial be found necessary in order to enable it to come to a final decision upon the points referred to. In answer to the last paragraph of the question, I have to say that an account of the special trials made by ships fitted with water-tube boilers is to be found in the memorandum on boilers presented to the House.

Sir F. Flannery said the hon. gentleman had not answered the last part of the question—whether any such test had been made—for no such information was given in the paper referred to.—Mr. Arnold-Forster: No test involving a passage to America or the Suez Canal has been made. All the trials that have been made are reported upon in the reports and memorandum referred to.

Sir F. Flannery asked whether the endurance of the water-tube boilers had been tested in an ocean passage.—Mr. Arnold-Forster: Many tests are adopted in the trials of ships, but no experimental trials other than those mentioned in the memorandum which had been presented to the House had been made.

Sir F. Flannery: Has any trial been made except for a few hours?

Obituary.—"Among the foremost men of his generation in physical science." So writes a *Times* correspondent in paying a tribute to the memory of the late Dr. George Francis Fitzgerald, of Trinity College, Dublin, who passed away on Thursday last week. Prof. Fitzgerald was a familiar figure in Section A at the yearly meetings of the British Association, and his observations were always well received. He knew when to praise and when to criticise the work of another, and an expression of opinion from him in relation to physical science and engineering matters was valued by many a striving student. He was president of the section in the year 1888. Our readers will remember that he was the first president of the Dublin Section of the Institution of Electrical Engineers. He was an F.R.S., and occupied the Chair of Experimental Philosophy at Dublin. In 1899 a Royal Medal was awarded to him by the Royal Society, chiefly, it is stated, in recognition of his researches in the domain of radiation and electrical energy. He was only 50 years of age when he passed away.

We regret to learn of the death at the comparatively early age of 47 years of M. Edouard Delamare-Deboutville, of Fontaine-le-Bourg, France. The deceased was a gas-engine expert of great repute, he being the inventor of the Simplex gas engine. Of late years his work has been centred in the utilisation of blast-furnace gases for the operation of gas engines, his system having been taken up by such large concerns as Creusot, in France, and Cockerill, in Belgium.

The Pacific Cable Scheme.—It would be ten thousand pities if, after having got so far, the Pacific cable were to be hindered in any way from having the much-desired healthy influence upon telegraphic communication between England and her Colonies. Although the contract for the manufacture and laying of the new cable has been placed, and although it had appeared to us that the organised opposition which had been presented against it from the first in London and Australia was no longer likely to be successful in delaying or crippling the undertaking, there are rumours in the air which do not leave us without apprehension of the ultimate issue. The Eastern Extension Company has been negotiating with certain of the Australian States for, and has actually secured, concessions, with the effect that the Canadian Government has felt it necessary to "consider her position as a contracting partner in the Pacific cable." This is followed by a dispatch from Melbourne that the Victorian Government has refused to accept the reduced rate of telegraphing to England offered by the Extension Company, and this refusal has caused much irritation in mercantile circles in Melbourne. Sir George Turner considers "Victoria bound in honour to maintain the 4s. 10d. rates until Great Britain, Canada, Queensland, and New Zealand agree to the Eastern Extension reduction." It may be taken for granted that the existing companies will leave no stone unturned, not only to protect their own interests, but to hinder the success of the Pacific cable as well; hence at the approach of actual competition, they have entered into lower-rate negotiations, for which concession on their part we suppose they get some *quid pro quo* to make them stronger to meet competition when it comes. It is to be regretted that the opposition should be able to disturb the accord which had been brought about among the interested Colonies. They have each guaranteed their proportion of the cost of laying and working the cable, and none of them should take any action likely to have a harmful effect upon

the success of the Imperial scheme without consulting the others. This, presumably, is the feeling of Canada when she expresses her desire to reconsider her position. The opposition of the Cable Companies has been so determined from the very first, and has caused such disastrous delays, that we cannot conceive of their being permitted to have any further influence in connection with the joint undertaking. A message which comes from Reuter's agent at Melbourne contains a statement which may, or may not, be of special significance. The Victorian Government is stated to be communicating with the Governments of Queensland and New Zealand, with a view to forwarding a combined message to the Pacific Cable Board, suggesting a joint-purse undertaking with the Eastern Extension Telegraph Company. All the information on this point is not at hand, but a joint-purse arrangement seems to us, to say the least of it, to be anything but desirable.

A Dearth of Apprentices. — In a letter which appeared in the *Times* of February 14th, the secretaries of a number of trades unions drew attention to the crying need for apprenticeship which exists in many trades. Amongst the trades unions whose officers attached their signatures to this letter were the Amalgamated Society of House Decorators, the Amalgamated Society of French Polishers, the Operative Plasterers' Association, the Electrical Trades Union, and the Goldsmiths' and Jewellers' Society. It was pointed out that the great majority of the working classes have no means of obtaining proper training in their trade; that technical schools, while they supply a part of the training which is requisite to produce a skilled workman, are not an efficient substitute for apprenticeship, and that the falling off in the number of apprentices (which is especially marked in London), is not due to any inherent defect in the system of apprenticeship, but that it is due to the want of organisation, *and in many cases to the want of money to pay premiums*. While we agree with the suggestion that some system of apprenticeship is extremely beneficial to every trade, it is, to say the least, a little odd to hear a cry for more apprentices from the responsible officers of a number of important unions. Assume that the wants above referred to are supplied; imagine that some government will find itself rich enough to pay the necessary premiums—the question then arises: Will the trades unions do their part? We have always been under the impression that one of the chief difficulties which beset the employer of skilled labour is to obtain the admission of apprentices to his workshop. For some inscrutable reason, at least one of the more important Unions (which, however, is not a signatory to the above letter) has made stringent regulations upon this subject—has even gone so far as to call a strike when too many apprentices were admitted to the works. The only apparent reason—if there can be reason of any kind in such conduct—is that an apprentice in the course of time becomes the rival of his former mentor. If masters were given to understand that to admit a reasonable number of apprentices would not involve a strike on the part of their mechanics, it is probable that with the increase in the number of their apprentices, they would find it possible to make a substantial reduction in the premium.

Marconi's Apparatus in the Navy. — In an article which recently appeared in these columns relative to experiments in wireless telegraphy taking place in Greece, an apparent injustice was done to Marconi's apparatus. We understand that the Marconi apparatus has since proved a great success, signals having, in one case, been exchanged, at a distance approaching 80 miles, between the *Renown* and the signal station at Malta, a distance which exceeds anything that has been achieved on the Greek coast. The *Renown* had been experimenting previously in conjunction with the *Vulcan*, and the trials, which at first seemed to go against Marconi's apparatus, seem to be attributable to want of experience in the adjustments, for the most recent trials have made rapid strides towards improvement. Some days much better results are obtained than others, but on the whole the experiments have been successful latterly.

Personal.—Mr. W. Wood has resigned the position of chief engineer to the Bristol Tram Company, and has joined the General Electric Company, Limited, of London, as manager of their electric traction supply department.

Mr. William Fisher's many friends will be interested to learn that he is leaving Messrs. Crompton & Co., Limited, at the end of March, after a somewhat close connection with Colonel Crompton for the past 10 years.

The Southport Electricity Committee has unanimously appointed Mr. Downe, second-in-charge at the Liverpool Electricity Works, to the position of borough electrical engineer at Southport, in place of Mr. C. D. Taite, who has obtained an appointment at Salford.

The salary of Mr. C. A. Cowell, the electrical engineer at Hanley electricity works, has been increased from £250 to £300; and that of the chief assistant, Mr. W. Adams, from £150 to £175.

Mr. T. H. W. Aldridge has been selected, out of over 80 applicants, for the post of chief electrical engineer to the Shanghai municipality, at a salary of £510 per annum, and he is leaving the staff of Messrs. Preece & Cardew to take up his new post.

The Paisley Town Council has appointed Mr. C. F. Parkinson, of Morecambe, to the vacant post of electrical engineer for the borough. The salary is £250.

In our "Notes" last week we stated that Mr. L. D. Price, of the Central London Railway, had been appointed to Manchester. This notice should have read "Mr. S. L. Pearce, of the Central London Railway, has been appointed deputy chief electrical engineer to Manchester," &c.

County Councils and Tramways.—At a meeting of the Executive Council of the County Councils Association, the Parliamentary Committee reported that they had considered the general working of the Light Railways Act, 1896, and the Tramways Act, 1870, so far as they relate to county councils; and, further, considered the desirability of a uniform gauge being prescribed for light railways and tramways; and resolved:—

(*a*) That, while in the opinion of this Committee it is generally desirable to have a uniform gauge of 4 ft. 8½ in. for both light railways and tramways, the Committee have not sufficient evidence before them to justify them in recommending that a uniform gauge for light railways and tramways should be prescribed by law; (*b*) that application be made to the Board of Trade to allow county councils to be heard in any case where the main roads in their area are affected by a tramway and light railway, whether such main roads are maintained by urban authorities or not.

Institution of Electrical Engineers (Manchester Section).—A meeting of members of the Manchester section of the Institution of Electrical Engineers was held in the new physical laboratory, Owens College, on Tuesday evening, February 26th. Dr. E. Hopkinson presided, and there was a good attendance of members. In opening the proceedings the chairman said that, referring to the matter mentioned in the minutes, of the application of the Manchester Society of Junior Electrical Engineers to become members of the local section, he might say that he had heard officially from the Institution in London, saying that the society could not be incorporated with the Institution as a body, but that those of its members who were already qualified could be proposed as students. The committee of the section would be glad if applications were made by members of the Junior Society of Electrical Engineers to be enrolled, and they would be forwarded to the proper quarter in London. Mr. G. A. Grindle, M.I.E.E., then read his paper on "The Use of Storage Batteries in Connection with Electric Tramways." A discussion followed.

Appointments Vacant.—A resident electrical engineer at £200 per annum is wanted for Morecambe; a charge engineer at £120 per annum is wanted for Plymouth; an account clerk for the West Bromwich electricity department; a shift engineer for the City and South London Railway; and the Manchester Tramways Committee wants an electrical engineer, also a permanent way engineer. See "Official Notices."

Italian Aluminium Transmission Lines.—An electrical transmission plant has just been completed in the valley of Pompeii, near Naples, Italy, in which aluminium is exclusively employed for line wire. The plant has been constructed for G. De Rossi & Co. by the Allgemeine Elektricitäts Gesellschaft, of Berlin, under the direction of Signor Silvio Piccoli, engineer and Neapolitan representative of that company. The *Electrical World* says that three horizontal reaction turbines of 150 H.P. at 190 revolutions per minute are each belted to a 100-KW. three-phase generator supplying current at 3,600 volts and 50 p. p. s. at 600 revolutions per minute. The current is transmitted at 3,000 volts by separate lines to the valley of Pompeii, to Sarno, and to Torre Annunziata, all three lines being of aluminium. The first-mentioned line is a little short of two miles in length and ends at a sub-station containing two three-phase transformers of 45 KW. each. Current is distributed from the sub-station for supplying 12 arc and 1,000 incandescent lamps, a water pumping plant and 10 three-phase motors installed in a printing establishment. The voltage of the distributing circuit is 200. The Sarno sub-station is nine miles distant from the power station. The current transmitted operates a 3,500-volt three-phase motor, which, in turn, operates a 36-KW. direct current dynamo supplying a 240-volt three-wire circuit for electric lighting during the evening and night. During the day the circuit supplies power for operating a pumping plant. The Torre Annunziata line is about two miles long. All the current is used for power purposes. There are 100 H.P. of motors of from 35—200 volts, the motors being practically employed in manufactories of macaroni. A fourth line from the generating plant is projected, which will lead to Castellamare, it being intended to replace the steam engines in the central station of that place by a 100-H.P. three-phase motor.

Lightning.—A few months ago our New York namesake made some original comments on the subject of lightning and lightning rods. Lightning was said to be a negligible quantity, and the lightning rod practically useless. The United States Weather Bureau has collected statistics for 1899 from which we find that the number of buildings damaged or destroyed by lightning in 1899 was 5,527 ; in addition to these, 729 buildings caught fire as a result of proximity to other structures that were fired by lightning. The approximate loss in 2,825 cases was $3,016,000. In 3,431 cases the amount of loss was not reported, owing undoubtedly in a majority of instances to the fact that it was very small. The *Electrical World* quotes the Bureau report to the effect that a conservative estimate of the total loss by lightning during the year would be $6,000,000. The great majority of buildings struck by lightning were not provided with lightning rods ; this was also the case in 1898. On the other hand, 70 buildings provided with rods were struck and damaged in 1899. These figures hardly confirm the statement as to the negligible quantity !

American Financiers and English Trams.—We give the following interesting item on the authority of the *St. James's Gazette* :—

A prospectus has been issued stating that Messrs. J. S. Morgan and Co., the London firm of Mr. J. Pierpont Morgan, the American millionaire, have underwritten £350,000 of preference shares of the British Electric Traction Company, Limited, the great promotion concern which has built, projected, and operates 60 or 70 electric tramlines throughout the United Kingdom. In consideration of underwriting this preference share issue of 30,000 shares, at £11 10s. per share, Mr. Morgan's company have received an option of the entire unissued share capital of the company, £800,000—enough to ensure them control. Included in the contract are no fewer than 57 cities and towns in the United Kingdom which the company will serve with electric tramways.

Sir J. Wolfe Barry and the Metropolitan Railway.—The *Financier* is informed "that Sir J. Wolfe Barry has just resigned his position as consulting engineer to the Metropolitan District Railway Company. This, we believe, may be taken as meaning that the Ganz system of electric traction will not be adopted by the company, inasmuch as Sir John was, according to engineering gossip, a strong believer in this system."

Lectures.—Before the Literary Society at Tarves last week, Mr. William Pickersgill, locomotive superintendent, Great North of Scotland Railway, from Aberdeen, gave a lecture on "Electric Driving, with Special Reference to Local Circumstances in Connection with a Tramway on the Methlick-Tarves Road, and the Water-Power at Methlick."

There was a debate at the Huddersfield Liberal Club on Saturday night, on "Municipal Trading." It was introduced by Mr. Arthur Priestman, of Bradford.

A lecture was given by Mr. J. W. Roebuck last Friday, before the Coventry Technical Institute Engineering Society on "Electric Ignition" for autocars and motor cycles.

Before the Junior Engineers' Association in Rochdale Technical School on 16th ult., Mr. C. C. Atchison lectured on "Features of Modern Electricity Supply."

On February 19th, before the members of the Cricklewood Literary and Social Union, Mr. Frank Tandy, A.I.E.E., lectured upon "Wireless Telegraphy."

A lecture on "Arc Lighting Systems" was delivered by Mr. J. Crichton Fulton to the members of the Glasgow and West of Scotland Engine-Keepers' Association, last week.

A lecture on "Electric Traction" was delivered by Mr. R. H. Haynes, borough engineer, to the members of the Newport Literary Society, recently.

The Problem Solved !—The Town Council of Falkirk, N.B., in granting liberty to a local church to have the Town Hall fitted up with the electric light for their bazaar, stipulated that the wire crossing the street shall be an insulated wire. In view of the recent tragic occurrences at Liverpool it was also suggested that when the scheme of the Falkirk electric tramways is submitted to them *the overhead wires should be also treated in the same manner*. How simple, and how neat ! To think that electricians should have left it to these "Wise men of Gotham" to solve the problem which has troubled us all so long.

Municipal Trading.—The Government has expressed its intention to re-appoint the Municipal Trading Committee, but Mr. Balfour has intimated to Sir Charles Dilke that it is undesirable that the re-appointment should be made the occasion for another debate on the subject in the Commons. That may be necessary policy in view of the great amount of work before Parliamentarians, but we cannot help thinking that it would be satisfactory for industrial reasons to obtain an idea as to the attitude of the new Parliament towards this very serious matter.

Electrical Undertakings, Limited. — The case of Harrower *v.* Howe, which is reported on page 359 of this issue, was concluded yesterday, judgment being given for the plaintiff, with £250 damages.

Changes of Address.—The Schattner Electricity Meter Company, Limited, is to-day removing from Norwich to Tyndale Works, Upper Street, Islington, London, N.

The Sturtevant Engineering Company, Limited, recently removed to 147, Queen Victoria Street, E.C.

Forthcoming Marriage. — It is announced that a marriage will shortly take place between Mr. J. Fletcher Moulton, K.C., M.P., F.R.S., and Mary May, daughter of Major and Mrs. Henry-Davis, of La Floridiana, Naples, and Thornden, Syracuse, N.Y.

Sale.—Messrs. Percy Huddleston & Co. hold an important sale of electrical stock and plant on Wednesday next at Bovay Street, Holloway, particulars of which are given in an advertisement.

The Naval Boiler Report.—The *Pall Mall Gazette* says :—"We have reason to believe that an interim report from the Boilers Committee has been handed to the Admiralty, and we fancy we shall not be far wrong in anticipating that, while the Belleville boiler will be condemned, it will nevertheless be maintained that water-tube boilers are *the* boilers for warships. We shall also not be surprised to hear that a wholesale removal of Belleville boilers from existing men-of-war is *not* recommended."

Subways.—Owing to the continually recurring trouble arising from disturbances of the public roadways for laying electric, telephone, and other underground works, the Leeds Corporation is going fully into the question of subways, and is sending a sub-committee to visit a number of towns to obtain information.

The Institution of Electrical Engineers. — Last night an extraordinary general meeting was held, and the discussion on Mr. W. L. Madgen's paper on the "Electric Power Bills" was resumed.

NEW COMPANIES REGISTERED.

C. Lindley & Co., Limited (69,356).—This company was registered on February 11th, with a capital of £60,000 in £1 shares, to acquire the business of merchants and manufacturers of engineers' stores carried on at London, Bradford and Sheffield by Richard H. N. Lindley, under the style or firm of "C. Lindley and Co.," and to carry on the business of electrical and mechanical engineers, &c. The first subscribers (each with one share) are:—Richard H. N. Lindley, 34, Englefield Road, De Beauvoir Town, N., merchant; Wallace J. Beken, 7, Listria Park, Stoke Newington, N., manager to dealer in engineers' stores; Miss Eva M. Page, Mrs. Elizabeth A. Page, and William Page, 34, Englefield Road, De Beauvoir Town, N., clerk; Frederick A. Tilley, 30, Monte Christo Mansions, Stoke Newington, N., clerk; and Walter Peacock, 10, Victoria Road, Shoreham, Sussex, warehouseman. No initial public issue. The number of directors is not to be less than two nor more than five; the first are Richard H. N. Lindley (chairman and managing director for life), Wallace J. Beken, and J. W. Gaukroger; qualification, 250 shares; remuneration as fixed by the company.

European McGuire Manufacturing Company, Limited (69,405).—This company was registered on February 19th, with a capital of £20,000 in £1 shares, to acquire certain patents and rights relating to electric motor trucks, sweepers, fenders, stoves, lifeguards, elastic brake hangers, brake handles, &c., to adopt an agreement with F. C. Buxton, and to carry on the business of engineers, electrical engineers, electrical equipment manufacturers, electric traction and lighting supply manufacturers, agents in Europe and elsewhere for the electrical products of the McGuire Manufacturing Company (Chicago), United States, America, and any other business which may be conveniently carried on in connection with the above. The first subscribers (each with one share) are:—F. W. Dunlop, 1, Grove Villas, Teddington, electrical engineer; J. G. Avery, 9, Torrington Square, Bloomsbury, W.C., assistant manager; F. Z. McGuire, 5, Warwick Court, Holborn, W.C., merchant; A. Ashbee, 21, James Street, Long Acre, W.C., wine and spirit agent; T. J. Leith, 20, Gateley Road, Brixton, S.W., clerk; T. L. Drimmie, 3B, The Mansions, Braham Gardens, South Kensington, financial agent; and J. D. Bancur, 5, Warwick Court, High Holborn, W.C., merchant. No initial public issue. The number of directors is not to be less than three nor more than seven; the first are L. Greville-Williams, W. A. McGuire, J. F. Cummings, F. C. Buxton, and W. H. Booth, M.Am.Soc.C.E.; qualification, £100; remuneration, £150 per annum, divisible. Registered office, 107, Long Acre, W.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Nernst Electric Light, Limited (60,807). — This company's annual return was filed on January 15th, when the entire capital of £320,000 in 180,000 ordinary and 140,000 preference shares of £1 each had been taken up. £1 has been called up on each of 115,000 shares, and £114,711 5s. has been paid. £288 15s. remains in arrears. £231 5s. has been paid on 520 forfeited shares. £235,000 is considered as paid on 180,000 ordinary and 25,000 preference shares. No mortgages or charges.

Direct United States Cable Company, Limited (11,597).—This company's annual return was filed on February 19th, when 60,710 shares were taken up out of a nominal capital of £1,300,000 in 65,000 shares of £20 each. All the shares are considered as fully paid. No mortgages or charges.

Pearson Fire Alarm System, Limited (59,967).—This company's annual return was filed on January 19th, when the entire capital of £150,000 in £1 shares had been taken up; £1 has been called up on each of 24,307 and 1s. on each of 5,700 shares, resulting in the receipt of £24,592; £119,993 is considered as paid on 199,993 shares. No mortgages or charges.

Electric Resistance and Heating Company, Limited (60,124).—This company's annual return was filed on January 25th, when 103,950 shares were taken up out of a nominal capital of £120,000 in £1 shares; £1 per share has been called up on 41,450, resulting in the receipt of £43,857 10s., including £2,137 10s. paid on 8,550 forfeited shares; £62,500 is considered as paid on 62,500 shares. No mortgages or charges.

Aberdare Electric Lighting Company, Limited (67,037).—This company's annual return was filed on February 5th, when 340 shares were taken up out of a nominal capital of £2,000 in £1 shares. No calls have been made.

General Electric Company (1900), Limited (67,307).—This company's annual return was filed on February 9th, when 50,007 shares were taken up out of a nominal capital of £800,000 in 80,000 shares of £10 each; £7 10s. has been called up on each of 18,000 shares and £10 on each of 7; £168,177 10s. has been paid, and £11.892 10s. remains uncalled. Mortgages and charges £200,000.

Electric Lighting and Traction Company of Australia, Limited (63,334).—This company's annual return was filed on January 21st, when 4,834 ordinary and 20,000 preference shares were taken up out of a nominal capital of £300,000 in 30,000 preference and 30,000 ordinary shares of £5 each. £110,015 has been paid on 2,003 ordinary and 20,000 preference, and 2,831 ordinary are considered as fully paid. Mortgages and charges, £65,000.

Kalgoorlie Electric Power and Lighting Corporation, Limited (63,248).—This company's annual return was filed on January 15th, when 175,000 shares were taken up out of a nominal capital of £225,000 in £1 shares. 10s. has been called up on each of 150,000, resulting in the receipt of £57,305 0s. 9d. £17,694 19s. 3d. remains in arrears. £25,000 is considered as paid on the remainder. No mortgages or charges.

Aron Electricity Meter, Limited (58,650).—This company's annual return was filed on January 3rd, when 125,000 ordinary and 124,896 preference shares were taken up out of a nominal capital of £250,000 in 125,000 ordinary and 125,000 preference shares of £1 each; £1 has been called up on each preference share, resulting in the receipt of £124,948 10s. (including £52 10s. paid on 104 forfeited shares). All the ordinary shares are considered as fully paid.

Accumulator Syndicate, Limited (52,514).—This company's annual return was filed on January 4th, when the entire capital of £30,000 in £1 shares was taken up; £1 has been called up on each of 5,000, resulting in the receipt of £5,000; £25,000 is considered as paid on the remainder.

Perth Electric Lighting Company, Limited (55,898).—This company's annual return was filed on January 15th, when seven shares were taken up out of a nominal capital of £1,000 in £1 shares. No calls have been made.

SUPPLY STATION ACCOUNTS.

Glasgow Corporation Electricity Accounts.

The Glasgow Corporation, a few years ago, was twitted with being very backward as regarded development of their electricity supply business, compared with the sister city of Edinburgh. The accounts now summarised show that this leeway is being rapidly made up, and that the commercial capital of the West of Scotland is likely to do big things when the present extensions Mr. Chamen, the city electrical engineer, has in hand are nearing completion. The progress made in the last few years is indicated by a few figures collected from the accounts and now set out:—

Quantity generated:—	1897.	1898.	1899.
Waterloo Street works ...	2,619,019	3,343,678	3,518,132
Port Dundas works ...	—	58,053	1,638,410
Kelvinside works	—	—	70,276
Percentage not accounted for	17·17 %	14·99 %	15·70%
Units sold, private consumers	1,885,902	2,566,016	3,788,795
„ „ public lamps ...	228,134	258,334	461,874
Number of public lamps ...	119	227	265

The capital account, like one other of the Scottish cities, shows each item depreciated. The general position of the undertaking is clear from the usual statement, which is as follows:—

General Statement.

	1898.	1899.	Increase.
Total capital expenditure ...	£339,782*	£609,485*	£269,703
Number of units sold	2,824,350	4,250,669	1,426,319
No. of 32-watt lamps connected ...	191,062	241,625	50,563
Total maximum supply demanded in KW.	6,114	7,732	1,618
Gross revenue	£44,141	£59,762	£15,621
Gross expenditure...	£24,013	£35,000	£10,987
Gross profit	£20,128	£24,762	£4,634
Average price per unit sold ...	3·75d.	3·37d.	−·38d.

* After deducting depreciation.

It may be interesting to compare the four most important provincial municipal undertakings:—

	Output.	Capital.	Revenue.	Total cost.	Net profit.
Edinburgh ...	5,551,728	£595,655	£63,659	1·41d.	£3,674
Glasgow ...	4,250,669	£609,485	£59,762	1·98d.	£3,221
Liverpool ...	5,729,477	£769,589	£73,504	1·41d.	£9,616
Manchester ...	6,355,872	£641,822	£85,832	1·87d.	£9,193

The net profit in the case of Glasgow and Liverpool is carried to depreciation or renewal and reserve funds. Manchester credits the rates, and Edinburgh carries it forward to be dealt with later. The receipts for energy sold are in the order of Edinburgh 2·72d., Liverpool (with traction) 2·89d., Manchester 3·23d., and Glasgow 3·37d.

Revenue Statement.

	1898. Gross.	1898. Per unit.	1899. Gross.	1899. Per unit.	Increase
Sale of energy	£44,141	3·75d.	**£59,762**	3·37d.	−·38d.
Meter rents	—	—	—	—	—
Sale of lamps, &c.	—	—	—	—	—
Sundry fees	—	—	—	—	—
Gross revenue ...	£44,141	3·75d.	**£59,762**	3·37d.	−·38d.

The revenue statement only includes the one item of energy sold, and this has increased by about 33 per cent., while the average price has dropped from 3¾d. to just over 3½d. In the general statement is given the total maximum supply demanded, the actual maximum load observed was 4,258 KW. on January 9th, 1900, which falls within the 1899 financial year. The capacity of plant to meet this was 6,402 KW. installed. We suppose consumers understand how they are charged for energy, but as there are no less than six methods or scales of prices for ordinary lighting and another rate for "power purposes," we imagine that gas consumers are at first puzzled to know what such complexity means. In London, St. Pancras also has several rates, to the mystification of the ordinary shopkeeper.

Cost of Production.

	1898. Gross.	1898. Per unit.	1899. Gross.	1899. Per unit.	Increase.
Coal and cartage of same ..	£6,401	·54d.	£12,997	**·73d.**	+·19d.
Oil, waste, water and engine room stores	700	·06d.	1,072	**·06d.**	·00d.
Salaries and wages incurred in generation and distribution	3,885	·33d.	5,439	**·31d.**	−·02d.
Repairs and maintenance engines, boilers, buildings, dynamos, &c., and attending and repairing public lamps	6,114	·52d.	7,624	**·43d.**	−·09d.
Works cost ...	£17,100	1·45d.	£27,132	**1·53d.**	+·08d.
Rent, rates and taxes ..	4,129	·35d.	4,549	**·26d.**	−·09d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	1,158	·10d.	1,564	**·09d.**	−·01d.
General establishment charges, stationery and printing, law charges and insurance	1,626	·14d.	1,755	**·10d.**	−·04d.
Other expenses	—	—	—	—	—
Total costs ...	£24,013	2·04d.	£35,000	**1·98d.**	−·06d.

The only marked change in the costs is in the first item. Coal has gone up from just over ½d. to nearly ¾d., but as all the other items (save oil, waste, &c., which remains stationary) have fallen, the total cost has been brought below 2d. In the revenue account depreciation appears as "costs," but we have transferred the sum under this head to the profit statement, as very few local authorities are given to debiting their cost sheet in this way.

Profit Statement.

	1898.	1899.
Interest on loans, &c.	£7,446	£15,256
Sinking fund for repayments	3,220	6,285
Net profit carried to depreciation fund	7,521	3,181
" " reserve fund	1,941	40
Gross profit	£20,128	£24,762

The financial charges have increased from £10,666 to £21,541, and as the revenue only increased by £15,621, the net profits have fallen from £9,462 to £3,221. Taken per unit, these amounts are:—

	1898.	1899.
Financial charges	·91d.	1·21d.
Net profit	·80d.	·18d.
Gross profit	1·71d.	1·39d.

The explanation of this is that interest had to be paid on money borrowed for new works which were unproductive in 1899, but considering that the financial charges more than doubled, the result cannot be regarded as at all unsatisfactory, particularly as the public get a very cheap supply.

Lancaster Corporation Electricity Accounts.

The electricity supply undertaking of the Lancaster Corporation is necessarily only a small concern, but it shows good results nevertheless, and upon these Mr. W. Alan Fraser, the engineer, must be congratulated.

General Statement.

	1898.	1899.	Increase.
Total capital expenditure ...	£28,663	**£32,795**	£4,132
Number of units sold	204,686	**277,259**	72,573
Number of lamps connected ...	18,129	**21,639**	3,510
Maximum load in KW.	250	**334**	84
Gross revenue	£4,134	**£4,504**	£370
Gross expenditure	£1,715	**£2,347**	£632
Gross profit	£2,419	**£2,157**	− £262
Average price per unit sold ...	4·69d.	**3·88d.**	−·81d.

In 1898 157,564 units were sold at 5d., and 19,330 at 4d. These prices were reduced, and in 1899 194,622 units were sold at 4½d., and 31,039 at 3d. These prices are the result of being able to generate the units sold at just over 2d. The output was distributed under heads, thus:—

Year.	Generated.	Public lighting.	Private supply.	Total sold.
1898 ...	220,329	27,672	177,014	204,684
		23 arcs.	17,807 lamps.	
1899 ...	316,749	51,598	225,661	277,259
		30 arcs.	21,219 lamps.	

The capacity of plant installed was 420 KW.

Revenue Statement.

	1898. Gross	1898. Per unit.	1899. Gross.	1899. Per unit.	Increase.
Sale of energy	£4,001	4·69d.	**£4,478**	3·88d.	−·81d.
Meter rents	1	·00d.	—	—	—
Sale and repairs of lamps and other apparatus	94	·11d.	—	—	−·11d.
Proportion of apprentices' premiums and costs refunded	38	·05d.	26	·02d.	−·03d.
Gross revenue ...	£4,134	4·85d.	**£4,504**	3·90d.	−·95d.

Coal repairs and salaries have gone up, and to these is added the loss made upon the cost of fittings, &c., upon consumers' premises. This last item in 1898 appears as a profit receipt of £94 in the revenue account. Coal, however, shows the only serious change, and this is swamped by economies in other directions, so that the total cost remain almost unaffected.

Cost of Production.

	1898. Gross.	1898. Per unit.	1899. Gross.	1899. Per unit.	Increase.
Coal	£540	·63d.	£853	**·74d.**	+·11d.
Oil, waste, water and engine room stores.	152	·18d.	139	**·12d.**	−·06d.
Salaries and wages incurred in generation and distribution.	433	·51d.	506	**·44d.**	−·07d.
Repairs and maintenance of engines, buildings, boilers, dynamos, &c., and street lamps.	226	·26d.	337	**·29d.**	+·03d.
Works costs ...	£1,351	1·58d.	£1,835	**1·59d.**	+·01d.
Rent, rates and taxes ..	97	·11d.	113	**·10d.**	−·01d.
Management expenses, salaries of managing engineer, secretary, clerks, &c., and audit fees.	152	·18d.	218	**·19d.**	+·01d.
General establishment charges, stationery and printing, law charges and insurance	115	·14d.	152	**·13d.**	−·01d.
Other expenses: Cost of labour and fittings upon consumers' premises	—	—	29	**·02d.**	+·02d.
Total costs ...	£1,715	2·01d.	£2,347	**2·03d.**	+·02d.

Owing to the reduction in prices charged the revenue has only increased by £370, while costs have risen by £632. The gross profit, therefore, suffers to the extent of £262, and as the interest, &c., charges take £458 more the net profits are roughly halved. The reserve fund, however, is increased by £250, and the local rates benefit by £421, this latter sum representing nearly 10 per cent. of the gross revenue, a contribution of no small amount considering the size of the works and that all charges are fully met.

Profit Statement.

	1898.	1899.
Interest on loans and bank overdraft	£751	£935
Sinking fund for repayments	277	551
Net profit carried to reserve fund	200	250
" " credit of district rates ..	1,191	421
Gross profit	£2,419	£2,157

CITY NOTES.

Electric Resistance and Heating Company.

An extraordinary general meeting of this company was held on February 26th at Winchester House, under the chairmanship of Mr. Cyril Wanklyn, to consider a resolution for the winding up of the company.

The Chairman, in submitting the resolution, said that meeting was the unfortunate sequel of the general meeting held in December last, and he could only say that the directors felt it as deeply as any of the shareholders at having been compelled to place that resolution before them, but they had no option at all in the matter. By continuing the business of the company with little or no funds, the directors felt they were incurring a heavy legal responsibility on themselves, and therefore thought to voluntarily wind up the company was the best course to pursue. Their liabilities amounted to something like £1,500 or £2,000, and it was doubtful whether the assets, apart from the patents, and assets which could be immediately realised, would cover the liabilities. He perhaps need scarcely remind them that since they last met, the directors had had the possibility of a reconstruction of the company, and restarting the business in many ways, before them. But after consideration, they had thought that without some form of a declared guarantee for providing new working capital, it would be quite impossible to put any form of reconstruction before the shareholders. They had had one plan, which provided for a guaranteed capital of £5,000, but they were of opinion that unless they could start with twice that sum, the business would be in a worse position than at present. Looking down the list of the shareholders of the company, it was found that any amount like £10,000 was entirely out of the question. As a proof of that, he would state that when the company asked for increased capital last June, and had given them notice of the position of the company, the response for the application of those shares amounted to £2,714, £1,800 of which was applied for by the board. Turning to the causes which had brought the company to its present position, the Chairman said, first and foremost, was the non-receipt of the increased working capital, which serious fact he had pointed out in his remarks at the general meeting. There was a further reason for their present position, which was that the process was undoubtedly represented to them to be in a more advanced position than was actually the case when they came to test it in actual practice. There were two or three points in which they were grievously disappointed, the first being that it was understood the resistance process was sparkless, and that there would be no danger attached to it. This was found not to be the case when tested, and that the process, if not dangerous, would prove deteriorating after some use. But they had overcome that defect. Another defect was the jumping, and there was also the defect of heating. These were three things among many which the directors had had to deal with, and which had meant an expenditure of money and trouble. He would, however, like to express his opinion that the process was not hopeless, the last ring manufactured by the company proving fairly satisfactory. It was possible that some of the shareholders would reproach the directors for an error of judgment when launching the process into a business. He would say that if the directors had make a mistake, it had been made in a good electrical company among influential electrical gentlemen who had been led away by reports submitted to them, and for himself he regretted that they had placed the process before the public at that particular moment. He hoped and believed, if that motion was passed that afternoon, arrangements would be made whereby the business of the company could be carried on, and he felt sure that every possible means would be taken to preserve the interests of every cash shareholder in the company. He concluded by moving the following resolution:—"That it has been proved to the satisfaction of this meeting that the company cannot by reason of its liabilities continue its business, and that it is advisable to wind up the same and accordingly that the company be wound up voluntarily."

Capt. Bax seconded the resolution, and said he had spoken to several electrical persons concerning the patents who believed it to be a good process, and he himself believed it only required money to bring it largely into use in the electrical world.

The resolution was agreed to.

On the motion of the Chairman, seconded by Mr. F. M. Guedalla, Mr. W. Chaplin, the secretary, was appointed liquidator to the company, at a remuneration of £105.

The proceedings then terminated.

National Telephone Company.

The annual general meeting of the shareholders of the National Telephone Company was held on Thursday of last week at the Cannon Street Hotel, Mr. J. S. Forbes in the chair.

The Chairman, in proposing the adoption of the report, said they would see that the income for the half-year had amounted to £732,000, which was an increase of £68,000 over the corresponding period of 1899. The working expenses were £404,000, as against £359,000—an increase of £45,000. £35,000 of that increased expenditure was due to the very severe snowstorm which occurred in the early part of the year. The net result of the half-year was that, after deducting the royalties due to the Post Office, there remained a profit of £255,000, which compared with £240,000—an increase of £15,787. There was an increase of £64,000 in the rentals carried forward for unexpired terms, the total amount being £696,568. Taken as a whole, the business of the year was a record one for the company, notwithstanding some very adverse circumstances they had had to contend with. It showed the greatest development in the history of the undertaking in any 12 months of the company's history. Under the circumstances the board had decided to adopt what they considered the wisest policy, and to pay a slightly diminished dividend. In doing that they were by no means in an isolated position, for most commercial undertakings had suffered in the same way. Turning to the capital expenditure, they would see that during the half-year that had amounted to £468,000, which was the cost of 11,794 additional exchanges and private lines and the construction of underground lines. That was a very large expenditure, but it was absolutely unavoidable, and that brought him to the whole root of the matter—were they to "cave in" or continue to fight on. They had come to the parting of the ways, and in his opinion they had a just cause for which to continue to fight. He thought they would have to do what others did who had a just cause and large interests at stake, and that was to fight for their own hand, but such a course would require very mature deliberation on the part of the board, because the difficulty was that they did not know what might be before them in the future. The Government had now become their competitors in London, and they had the power to grant licenses outside the Metropolitan area, but their company's life was very short, as their license expired in 1911. The question was—what would happen at the end of that time? and none of them could answer the query. Every seventh year it was in the power of the Government to take over their business on arbitration terms, and the next period for exercising that power was in 1904, and it might be that they would then elect to take over the company under their powers. They all had a great deal to learn between now and 1904, and, with the greatest respect to the Government, he considered that they had a great deal to learn too, and if they persisted in competing with them by offering very low rates, he was afraid they would have a very sorry tale to tell. After much anxious consideration, the board had come to the conclusion that, subject to the sanction of the shareholders, they would continue to fight, to relax no reasonable effort to increase the number of their subscribers, and to make the best of their property generally. Of course they were not likely to invite opposition from the Government or anybody else by cutting down rates, but they might be forced to do that on the principle of "follow my leader." Dealing with 1891 as a whole, he said they had erected 23,490 additional exchange and private lines, and of that number 16,776 had been for the use of subscribers on the message rate system. That was, that the customer paid a low annual charge for the installation, and, in addition, 1d. for each call. He understood that the Government intended to develop that system, and if so, he wished them joy of it, if their result turned out to be anything like what the company had got from it. They had spent half a million of money experimentally on that system, and they had not received a farthing interest on the outlay. They could not afford to give services of that kind for nothing, but, of course, if competition forced their hands, they would have to take their chance.

Sir H. Fowler, M.P., seconded the resolution.

Mr. Lee Smith said it seemed to him that the Government were treating the company in a most unfair manner. They had stood by while it struggled on and surmounted its initial difficulties, and now they proposed to swoop down upon it to the detriment of the shareholders who had put their money into it. The company had done an immense amount of good for the benefit of the public at large, and he questioned very much whether they were justified in continuing the heavy capital expenditure.

The Chairman, in reply, said of course the board felt as indignant as the shareholders at the way in which the Government had treated them, but still they had to meet them as competitors, and to an extent they must suppress their indignation. They had tried all they could to work in friendly competition with the Post Office, but without success. He believed that if the shareholders supported them they would be able to beat the Government, because they were not tied down by red tape. Time alone, however, would show whether or not he was right in that opinion.

The report was then carried.

The Chairman then proposed resolutions for increasing the capital of the company by the conversion of 590,000 fully paid (issued) and 10,000 (unissued) ordinary shares into preferred and deferred stock; the issuing of 200,000 of the unissued ordinary stock as preferred shares. He also proposed to alter the articles of association authorising the board to pay a commission not exceeding 5 per cent. for underwriting in connection with any offer of shares that might be made to the public. He explained that if they were to develop the business and fight for their own interests as the board had determined, it was absolutely essential that they should have the further capital now asked for.

Sir H. Fowler seconded the resolutions, which were carried.

Westminster Electric Supply Corporation.

The ordinary general meeting of the proprietors of this corporation was held on February 27th, at the offices of the company, Eccleston Place, Belgravia, S.W., the Right Hon. Lord Suffield (the chairman) presiding.

In moving the adoption of the report, the Chairman said he regretted to have to state that there was a reduced dividend on that occasion, for although they had added to their contracts for over 40,000 lamps during the past 12 months, like all other users of Welsh steam coal, they had been hit by the rise in the price of that article, and their profits had also been effected by the rebate made to con-

sumers taking their supply at 200 volts, and by a considerable increase in rates and taxes. It must be remembered that during the year, in accordance with resolutions passed at the extraordinary general meetings, ordinary share capital to the amount of £148,100 had been duly issued at par to the shareholders. A large proportion of this sum had been expended on the joint undertaking of the St. James's and Pall Mall Company and that corporation in the purchase of lands and erection of works at North Bank, Marylebone. That capital must necessarily, until the opening of the works for supply purposes, remain unremunerative. They would be pleased to learn that, after negotiations extending over two years, the directors had come to an agreement with the Vestry of St. George's, Hanover Square, for lighting the whole of the parish with electricity. He need not say that that was an important matter. As was stated in the report, the share capital sanctioned at the last meeting of the company had been issued to the shareholders at par, with the exception of a small balance which had now been taken up by persons who were not shareholders, residing in different parts of the globe. The question of provision of the further capital would be considered by the board in due course. The directors very much regretted to lose the services of Lord Ampthill, who had taken a deep interest as a director in the affairs and works of the corporation, but the board considered that they had been very fortunate in appointing Lord Kinnaird in his place. Lord Kinnaird was known to a great many of the shareholders as a thorough business man, and who was prepared to devote the greater part of his time to the interest of that company. He did not think there were any other matters to which he had to draw their attention, but he would be pleased to answer any questions the shareholders might wish to ask.

Mr. Edmund Boulnois, M.P., seconded the motion,

Mr. George Hicks said he would like to know whether the directors did not think it best that their company with 1½ million of capital should hold their meeting in future in the City of London, as it was not very convenient for the shareholders to come there to attend those meetings, and he would propose that the meeting be held in future in the City.

The Chairman said it would, perhaps, be better for the board to consider the matter first before passing any resolution on it, and for them to take what action they thought was necessary.

Mr. Hicks agreed to this, and withdrew his resolution.

Mr. E. P. Reed said he wished to know the date at which they hoped to have the works at North Bank ready.

Prof. Kennedy replying, said the plant for the central station was on order, and a great deal of it was now completed. The section, which was absolutely for their working, had been arranged to be put up at the company's works in the course of the summer, but the actual buildings at North Bank could not be ready until next August twelvemonth.

Mr. Reed congratulated the board on the highly satisfactory state of the accounts and the handsome sum they had been able to put to the reserve fund.

Replying to a question, Prof. Kennedy said he had no doubt that their coal contracts would be more favourable to the company than in the past year.

The report was then adopted.

The re-election of the two retiring directors was then proceeded with, and a vote of thanks to the chairman for presiding concluded the proceedings.

Galloways, Limited, Manchester.

We are informed that the annual meeting of this company was held on Tuesday, Mr. Charles J. Galloway presiding. In congratulating the shareholders on the general results of the year's working, he remarked that the gross profits amounted to £26,401 1s. 3d., after providing for liberal depreciation and the payment of directors' fees; with the balance brought forward, the total amount standing to credit of profit and loss account, was £26,928 16s. 6d. After deducting interest on debenture stock, dividends on 5 per cent. preference shares, and half cost of the installation at the Paris Exhibition, there remained a disposable balance of £13,312 16s. 6d., the recommendations of the directors in respect to which met with the unanimous approval of the shareholders, namely, the payment of a dividend at the rate of 6 per cent. per annum on the ordinary shares, the transfer of £3,000 to special reserve fund (making the total amount of this fund £14,438 2s. 8d.), the transfer of £1,500 to special depreciation account, and the carrying forward of £574 16s. 6d.

In moving the adoption of the directors' report and statement of accounts, the Chairman remarked that the important and extensive structural alterations and additions at the Knott Mill works, to which reference was made at the last general meeting, were now rapidly approaching completion, and the directors looked with confidence to very satisfactory results therefrom. To meet this expenditure and to provide for additional machinery, plant, &c., required for the manufacture of high-speed engines, the directors had resolved upon a further issue of 2,746 ordinary shares of £10 each—equal to one-fifth the number of ordinary shares previously issued—and all these shares had been offered to and taken up by the present shareholders. Adverting to the Paris Exhibition, the chairman remarked that probably it was unique in the history of any engineering firm to be able to record, as they could, that at three consecutive International Exhibitions they had gained the Grand Prix—the highest award. In the face of the pessimistic views expressed by many people as to the trade of the future, it was gratifying to him to be able to state that all the departments were fully engaged, the New Year having opened very well for the company.

The Metropolitan Electric Supply Company.

The directors' report reads:—"The directors submit the following statement of the company's accounts for the year ending December 31st, 1900, prepared in the form prescribed by the Board of Trade under the provisions of the Electric Lighting Acts, 1882 and 1888. The capital expenditure, which at the end of 1899 amounted to £1,244,254 1s. 6d., has now reached a total of £1,417,805 8s. 11d., being an increase during the year of £173,551 7s. 5d. The principal items of expenditure were for the works at Willesden, and for the extension of the low tension system. During the past year the capital has been increased by the issue of £125,000, being the balance of the 3½ per cent. mortgage debenture stock, and also by the issue of 15,000 ordinary shares of £10 each to the shareholders at par, being the balance of the company's authorised share capital. The gross revenue for the year amounted to £209,420 6s. 1d., as compared with £179,190 1s. 10d. in 1899, being an increase of £30,230 4s. 3d. The cost of generation, which in 1899 was £90,419 7s. 1d., amounted in 1900 to £106,009 4s. 9d., or an increase of £15,589 17s. 8d. To meet the rapidly increasing demands for current, a fourth steam generator of 1,500-kw. capacity is in course of erection at the Willesden works, and a fifth machine of similar size has been ordered and will be erected in the course of the summer. During the year negotiations took place with the Marylebone Vestry for the sale to them of the company's West London (Marylebone) undertaking. A provisional agreement, subject to the approval of the Vestry and the shareholders respectively, was entered into on terms which, in the opinion of the board, were fair and reasonable. The agreement was approved by the Vestry on August 3rd, but at a subsequent meeting held on October 16th the Vestry decided that the resolution approving the agreement should not be confirmed. The balance at the credit of the revenue account, before providing for depreciation, is £78,500 10s. 5d. The directors have set aside £14,000 as an addition to the depreciation and reserve fund, which now amounts to £78,422 5s. 10d., carrying to the credit of the net revenue account (No. 5) the sum of £64,500 10s. 5d., which, with the balance brought forward from last account and other receipts, makes a total of £71,840 18s. 9d. After deducting debenture and share interest and other charges, there remains a balance of £27,841 1s. 3d. An interim dividend of 6s. per share on the ordinary share capital was paid on Augus 11th, 1900, amounting to £25,500, and the directors recommend that a further dividend of 6s. per share on such shares be now paid, making a total distribution of 12s. per share for the year, being at the rate of 6 per cent., together with the proportionate payment of 9d. per share on the new shares. This will absorb a further sum of £26,016 6s. 9d., and leave a balance of £1,824 14s. 6d. to be carried forward to the next account. The directors consider that this result is satisfactory, having regard to the high price of coal generally, especially during the last three months of the year. The number of 8-c.p. lamps supplied by the company increased during the year from 500,000 to 570,000. The present number of lamps connected is 578,000, and the applications show no signs of decrease. A report from the company's engineer is appended, showing that the stations, machinery, and plant have been maintained in a satisfactory condition. In accordance with the articles of association, the following directors, viz., the Hon. J. B. Lubbock, Sir James Pender, Bart., and J. Carr Saunders, Esq., retire from the board, and are eligible and offer themselves for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths & Co., also retire, and are eligible and offer themselves for re-election."

The annual meeting is to be held at Winchester House on Tuesday next at 12 o'clock noon.

British Insulated Wire Company, Limited.

Mr. Marriner Brigg presided at the annual meeting of this company, held at the Adelphi Hotel, Liverpool, on Monday.

The Chairman, in moving the adoption of the report, said that the gross profit for the year had been a very pleasant surprise to the directors. In view of the development during the last two years of electrical undertakings, which, of course, meant increased competition, which in its turn usually represented a larger turnover and less profit, he was glad to say that in the case of this company the profits had been fully maintained, indeed increased. Last year, it would be remembered, a bonus of 5 per cent. had been paid in addition to the dividend, but that was under exceptional circumstances; large profits had been made, and it had been decided to make a further issue of capital, but the shareholders at that time had preferred that the profits should be fully divided amongst the existing shareholders, and should not be left for division amongst those who might subsequently come in as new shareholders; therefore it was, that the bonus of the previous year had not been repeated on this occasion. The company required all the strength it could possibly get, for they had a great amount of work in hand and in prospect; further, the directors deemed it very desirable to establish a strong reserve, which now amounted to the very handsome sum of £200,000, this having been created to the extent of £177,000 by the premiums of the new shares issued last year, and by the sum of £22,400 now proposed to be transferred. Referring to the investments, the chairman said these had been most carefully considered in the best interests of the company, and had been the means, as it was intended they should be, of obtaining for the company valuable contracts. The investments were now worth much more than was given for them.

Mr. Alderman Snape, J.P., seconded the motion, and said the past year had brought to the company a larger amount of business than they had known in any previous year, and also the largest amount of profit. In both respects they had broken the record.

The report was, therefore, so satisfactory that it needed no commendation from him; he must, however, congratulate the shareholders upon what he must call the astounding growth of business which had characterised the progress of the company. The question might naturally enter their minds whether they might look for a similar growth in future. Of course he could not prophesy upon such a point, but he could form some sort of estimate from the present conditions, and having in mind that on every hand electrical enterprises were increasing to an enormous extent, he thought there was every reason to anticipate that the company would get as fair a share of work in the future as they had enjoyed in the past. One notable feature of the company's working was that it made practically no bad debts, their customers being mostly Corporations and public bodies, and even the Government, none of whom had hitherto had to compound with their creditors. The work of the company was likely to increase, because not only was the Government extending its trunk telephone service by means of underground cables, but municipalities were following suit, and in Liverpool, owing to the recent accidents, the National Telephone Company were actively engaged in transforming their overhead system into an underground system. The company had also valuable connections with Australia and other colonies, and from a recent visit he had paid to Australia, he could testify to the rapid growth of certain cities, and the widespread development of electrical tramways and other organisations offering a market for the products of the company. Some of the investments of the company had been, for business reasons, placed in these Colonial undertakings, and he, for one, anticipated that the result would ultimately be a very considerable profit to the company.

The motion for the adoption of the report was carried unanimously. The other resolutions declaring dividend, re-electing directors and auditors, &c., were also carried.

1899); the serious loss of income due to the fire at Maiden Lane Station in March last, and the further consequent heavy distribution losses pending the reinstatement of damaged plant and machinery. The fire loss on capital account is being written off share premium account. In accordance with the arrangements authorised at the extraordinary meeting of the company held on May 17th, 1900, the sum of £73,670 16s. 10d. has been lent to the Charing Cross & City Electric Company on account of £200,000 authorised. The net earnings, as shown in the revenue account, have amounted to £29,517 1s. 3d. A sum of £2,182 2s. 9d. has been paid in respect of interest on debentures and temporary loans up to December 31st, 1900, and £10,625 was distributed as interim dividend, at the rate of 8½ per cent. per annum for the half-year ended June 30th, 1900. There remains a sum of £16,709 18s. 6d., which, added to the undivided profit of £4,541 13s. 10d. from the preceding year's account, and £1,161 4s. 7d. received for interest on advances, makes £22,412 16s. 11d., which the directors propose to deal with as follows:—

To provide for dividend on 4½ per cent. preference shares	£7,052	1	0
To pay a dividend at the rate of £9½ per cent. for the half-year ended December 31st, 1900, on the ordinary shares (making with the interim dividend paid in August, 1900, £9 per cent. for the whole year)	11,875	0	0
And to carry forward	3,485	15	11
	£22,412	16	11

"Mr. W. F. Fladgate and Mr. R. Chadwick are the directors who retire by rotation, and, being eligible, offer themselves for re-election.

"The auditors, Messrs. O. R. Johnson & Son, also retire, and offer themselves for re-election."

Statement of Electricity Generated, Sold, &c. (Charing Cross Company).

Quantity generated in B.T. units.	Quantity sold.				Quantity used on works.	Total quantity accounted for.	Quantity not accounted for.	Number of public lamps.	Total maximum supply demanded. KW.
	Public lamps.	By contract.	Private consumers by meter.	Total sold.					
6,572,739	139,921	—	4,857,260	4,997,181	1,564,582	6,561,763	10,976	113	3,049

The Charing Cross and Strand Electricity Supply Corporation.

The directors' report to be presented at the meeting to be held at St. Martin's Town Hall to-day reads as follows:—

"In submitting the accounts for the year ended December 31st, 1900, the directors are glad to be able to put before the shareholders a satisfactory report of the working of the company.

"*West End Areas.*—The building extensions at the Lambeth Station have been completed, and the entire site is occupied by the generating station, which is now fully equipped. The sub-station buildings at Short's Gardens have also been completed and partially equipped. 1,500 KW. in motor-generators, and 400 KW. in batteries have been installed. The plant and machinery at these stations and at the Maiden Lane Station have been maintained in a high state of efficiency. The increase in the Corporation's business has necessitated the erection of a further sub-station to supplement the existing stations in use for the West End areas, and a site has been acquired in St. Martin's Lane, in the rear part of which a sub-station is being erected, while, in the front, offices are being built to accommodate the staff necessary to carry on the general business of the Corporation.

"*City Area.*—An Act empowering the Corporation to acquire land and erect generating stations at Marsh Gate Lane, Bow, was passed in the Session of 1900. The Act also empowered the Corporation, upon terms to be approved by the Board of Trade, to supply electric energy in bulk to certain local authorities in the East End. The site acquired under this Act consists of 7½ acres of freehold land, on part of which the generating station is being erected for the City order. Sites for sub-stations have been secured at Fenchurch Street and Ludgate Hill. Building operations are in progress on these sites, and negotiations are proceeding for other necessary sites. Motor-generators and batteries are being installed at Ludgate Hill sub-station, and supply is already given from that station to part of the City area.

"The growth of the Corporation's business in all its areas has been satisfactory. The equivalent of 39,431 additional 8-C.P. lamps (36,004 in the Western areas, 3,427 in the City area) have been connected to the mains of the Corporation, making a total of 222,120 lamps now connected, while negotiations are proceeding in the several areas for a supply to nearly 50,000 additional 8-C.P. lamps, of which a large proportion are in the City area. There have been 22 miles added to the mains in the West End areas, and 27 miles in the City area, making the total mains laid 174 miles. The units sold during the year 1900 show an increase of 995,132 over those sold during 1899. The increase of gross revenue from sales of current in 1900 over 1899 was £15,962, as compared with an increase of £10,715 in 1899 over 1898, *i.e.*, an increase of nearly 50 per cent. The directors have reason to congratulate the shareholders on the satisfactory results of the year's trading, which would have been even more satisfactory but for the price of coal (entailing an increased expenditure of nearly 30 per cent. over the price paid in

Volenite, Limited.

An extraordinary general meeting of this company was held in Dublin last week, Mr. Thomas Falls presiding, to consider an offer which had been made for the company's assets.

The Chairman explained that an agreement dated February 12th last had been made between their directors and General Beresford, for the sale to him of all their assets for £200,000 in cash and 75,000 £1 shares in a new company. He held General Beresford's cheque for £1,000, the forfeitable deposit, to be returned if the contract was not confirmed that day. He said there was too much uncertainty as to whether they had anything to sell or not, but if after testing their samples, he (General Beresford) elected within four months to proceed, he would put up £199,000 cash, as provided by the agreement.

The solicitor to the company read the resolution setting forth the terms of the agreement and authorising the directors to carry the agreement into effect, and this was carried.

Blackpool and Fleetwood Tramroad Company.

A general meeting of this company was held at Manchester on 19th ult. Mr. George Richardson, chairman, presided. The report showed a profit on the year's working of over £10,000, and a dividend at the rate of 9 per cent.

The Chairman, in moving the adoption of the report and balance-sheet, referred to them as being satisfactory. The working expenses showed an increase owing to the high price of coal. An extra receipt in this year's account was £362 for the sale of current to the Corporation of Blackpool, owing to the breakdown of their own system. The dividend was down 1 per cent., but in this they were only faring like other railway and tramway concerns throughout the country.

Mr. R. H. Prestwich, deputy-chairman, seconded the report, which was unanimously adopted.

Northampton Electric Light and Power Company.

The twelfth annual report, presented at the annual meeting on February 28th, reads:—

During the year 1900, 5,899 additional lamps (of 8 C.P.) have been fixed, and motive power equal to 297 lamps, together 5,696, as compared with 6,702 for the previous year, bringing up the total to 25,459 lamps. The mains have been extended about 1¼ miles, making a total length of about 7½ miles. The number of consumers has been increased by 106, making 445 in all. The increase in the price of coal has seriously affected the results of the year's working, but in addition to this there has been great and unexpected delay in the delivery of machinery, upon which the change to a higher voltage was dependent. This step, which should have taken place during the summer months, was necessarily postponed until after Christmas, and can then only be satisfactorily undertaken during a few days of fine weather. Meantime, the plant has been working uneconomically, with the result that no improvement can be recorded so far as net revenue is concerned. This state of things has induced the directors to institute a further and thorough inspection of all the works and plant, with the

recent additions, and also a critical examination of system and methods of working. They are glad to learn that the whole concern is in a very sound condition, but various improvements have been suggested with a view to more economical working in combination with greater efficiency, and there is every reason to hope that under the new conditions which will be in force, there will be no further disappointment in regard to financial results. The accounts show £1 183 1s. 1d. to the credit of net revenue. It is proposed to pay dividends on the 6 per cent. (fixed) preference shares, £229; on the 5 per cent. (fixed) preference shares, £418 8s 8d.; a so 2 per ce t. on the ordinary shares, amounting to £439 18s. 8d., which will leave £45 15s. 9d. to be carried forward.

W. T. Henley's Telegraph Works Company.

The report presented to the meeting held at Cannon Street Hotel yesterday reads:—

The directors beg to submit their annual report. Of the additional capital authorised by the shareholders in August, the directors have issued £25,000 preference shares at par, and £25,000 ordinary shares at 100 per cent. premium, the latter enabling the reserve account to be increased by £25,000. These shares were all issued to the shareholders or their nominees. The annexed accounts show that during the past year a net profit has been made of £2 723 1s. 6d. After payment of debenture interest and income tax, and making ample allowance for depreciation of buildings, plant, machinery, &c., there remains £56,411 17s. 10d., making, with £18,853 7s. 4d. brought forward from last year, a total of £75,265 5s. 2d. available for distribution. The directors have transferred £1,000 to the debenture redemption sinking fund, and £11,000 to the reserve account (in addition to the £ 5,000 above mentioned), and they recommend the payment of the following dividends, viz.:—On the preference shares at the rate of 4½ per cent per annum (less income-tax), and on the ordinary shares at the rate of 20 per cent. per annum (less income-tax) including the interim dividend of 4 per cent. paid on September 1st last. These payments will, together, amount to £50,554 9s. 2d., leaving £24,710 16s. to be carried forward. The dividend warrants will be posted on February 28th, 1901. The Earl of Galloway and Sir Henry M. Stanley, G.C.B., retire by rotation in accordance with the provisions of the articles of association, and, being eligible, offer themselves for re-election. The auditors, Messrs. Ball, Baker, Deed, Cornish & Co., retire, and, being eligible, offer themselves for re-election.

Newcastle-upon-Tyne Electric Supply Company.

The directors' report reads:—

The directors, in presenting the balance-sheet and profit and loss account for the year ending December 31st, 1900, have pleasure in stating that the total units sold for the year amounted to 1,095,519, as against 967,098 in 1899, and 803,779 in the year 1898.

The profits of the year, including the balance of £1,811 1s. 6d. brought forward from 1899, amount to £10,605 6 11

out of which interim dividends at the rate of 5 per cent. per annum upon the amount paid up on the preference shares, and at the rate of 8 per cent. per annum upon the ordinary shares were paid in July last, absorbing 3,680 2 3

£6,925 4 8

The directors now recommend the payment of further dividends at the rate of 5 per cent. per annum on the amount paid up on the preference shares, and at the rate of 8 per cent. per annum upon the ordinary shares, absorbing 4 537 13 10

and that the balance of £2 387 10 10

be carried to next year.

The high price of coal which ruled during the year has increased the cost of production compared with the previous year by £1 600. At present prices the larger portion of this increased expense will be saved during the current year. The reserve and depreciation account, which at December 31st, 1899, stood at £20 000, has been increased during the year by the sum of £20.000, being the premium of £1 per share on the 20,000 preference shares issued, and now stands at £40,000. Two sets of plant, with a capacity of 500 kw. each, have been erected at Pandon Dene, so that the continuous current service referred to in the last report is now supplying current in the city of Newcastle-upon-Tyne. The Bills which were promoted in Parliament last year, to give powers to the company outside the area of their original provisional order, and also for the supply of electricity in Gosforth, have been successfully carried through, as reported to the shareholders on December 20th last. Pursuing the policy foreshadowed in that report, the company is now in possession of an extensive central generating station at Wallsend, having taken over and enlarged a station commenced by the Walker and Wallsend Union Gas Company. A suitable riverside site at Carville, the provisions for the purchase of which were included in the company's Bill of last year, has also been secured upon satisfactory terms, and is available for future development. The central generating station is under the management of a joint committee of the directors of this company and of the Walker and Wallsend Union Gas Company. The company, under the above arrangements, is in a position to meet the present and growing demand for electricity for both power and other purposes. The purchase price of the riverside site referred to above was settled at £2?,500. on the understanding that the vendors received preference shares for their purchase money, and in settlement thereof there were allotted to them in January of the present year 8,750 5 per cent. fully-paid preference shares of £6 per share, £1 of which is premium. This allotment is additional to the 20,000 preference shares issued at a premium of £1 to the shareholders during the year 1900, and there now remains unissued 10.000 ordinary shares, and 6,2 0 preference shares, which will be offered to the shareholders of the company on the same terms as the last issue, during the forthcoming autumn, by which time it is expected the remaining calls will have been made on all the allotted shares. The directors propose to create 4 per cent. mortgage debentures to the amount of £250,000, which will be issued from time to time as the extended operations of the company require, the total issue not to exceed one-half of the paid-up capital. Towards this contemplated issue, considerable sums have already been received and are treated in the accounts as loans. The expenditure on capital account during the year has amounted to £127,261 2s. 9d., the greater portion of which was not productive of revenue during the year. The board has been increased under Article 74, as amended by special resolution dated October 4th, 1900, and the directors have pleasure in stating that they have secured as colleagues Sir Lindsay Wood, Bart., Mr. J. H. B. Noble, ar. F. W. Dendy, and Mr. G. B. Hunter. The confirmation of the appointment of these gentlemen as directors is required under the articles of association at this meeting. The directors regret to have to report the loss of the valued services of Colonel F. F. Sheppee, who, owing to his having ceased to reside in the district, has resigned his seat on the board. Consequent upon this resignation Dr. J. T. Merz is the only director who retires by rotation. He is eligible, and offers himself for re-election. The auditor, Mr. Thomas Harrison, also retires, and is eligible for re-election.

The Brompton and Kensington Electricity Supply Company.

The annual report for the year ended December 31st, 1900, submitted to the meeting held at Winchester House yesterday, reads as follows:—

In submitting to the shareholders the balance-sheet and accounts for the year ended December 31st, 1900, the directors beg to report that the revenue account shows a credit balance of £21,344 3s. 7d., which, with the balance of £229 4s. brought forward, and £282 18s. 5d. balance of interest received, makes a total of £21,856 1s. After deducting £2,250 for interest on debenture stock paid and accrued, £3,100 for interim dividend paid on the 7 per cent. cumulative preference shares, and £2,457 12s. 6d. for interim dividend at the rate of 5 per cent. per annum for the half-year to June 30th, 1900, on the ordinary shares, the directors recommend that the sum remaining, viz., £15,048 8s. 6d., be dealt with as follows:—

To credit of depreciation account	£6,000 0 0	
In reduction of renewals suspense account ..	3,000 0 0	
		£9,000 0 0
To payment of the remainder of dividend to December 31st, 1900, on the 7 per cent. cumulative preference shares ..		2,100 0 0
To payment of a dividend on the ordinary shares for the half-year to December 31st, 1900, at 7 per cent. per annum, making 6 per cent. for the year		3,440 13 6
And that the balance of .. .. be carried forward to the next account.		487 15 0
Total		£15,028 8 6

The following table shows the progress of the company's business:—

Year	Equivalent of 25-watt (8-c.p.) lamps connected.	Increase in 25-watt (8-c.p.) lamps.	No. of customers connected.	Gross receipts.	Expenditure.	Net receipts.
				£ s. d.	£ s. d.	£ s. d.
1890	13,665	9,145	248	5,010 9 2	4,624 6 5	386 2 9
1891	19,388	5,723	573	8,358 3 11	6,077 14 10	2,280 9 1
1892	23,700	4,312	471	10,688 18 6	7,851 19 6	2,836 19 0
1893	28,429	4,729	599	12,063 10 10	7,832 6 8	4,231 4 2
1894	35,858	7,429	755	13,695 11 8	7,431 16 8	6,264 15 0
1895	44,162	8,304	932	15,894 16 11	8,554 0 10	6 840 16 1
1896	55,285	11,103	1,164	17,442 6 5	8,410 8 4	9,031 18 1
1897	66,364	11,099	1,416	20,810 10 1	8,777 5 2	12,033 4 11
1898	80,301	13,937	1,777	24,906 17 11	10,840 14 11	14,066 3 0
1899	95,803	15,502	2,112	30,416 13 4	12,235 16 10	18,180 16 6
1900	108,978	13,675	2,395	36,125 4 5	14,801 0 10	21,324 3 7

In accordance with the special resolution passed January 10th, 1901, the nominal capital of the company is now £300,000, divided into 20,000 preference shares of £5 each, and 40,000 ordinary shares of £5 each. The directors now propose to issue 8,000 preference shares and 339 ordinary shares, bringing the ordinary and preference capital up to £100,000 each, and to redeem the existing debenture stock. The renewal of antiquated plant has been completed during the year at a further cost of £2,992 16s. 10d., and after appropriating £3,000 from the income of the year, the renewals suspense account stands at £14,194 16s. 10d. Mr. W. R. Davies and Mr. W. F. Leese retire from the board by rotation, and, being eligible, offer themselves for re-election. Messrs. Miall, Wilkins, Randall & Co., the auditors of the company, offer themselves for re-election.

Chelsea Electricity Supply Company, Limited.

The directors' report reads as follows:—

The directors beg to submit to the shareholders the report and statement of accounts for the year ended December 31st, 1900. In October, 1900, an allotment of 14,000 ordinary shares at a price of £6 per share was made *pro rata* to the shareholders, and at December 31st allotments of 9,805 shares had been taken up. The balance of premium received in 1900, after deducting cost of issue and certain exceptional expenses, has been carried, as on previous occasions, to the reserve fund. The total of the reserve fund now stands at £56,6 2 13s 5d. In order to conform to the Companies' Act, 1900, some alterations in the articles of association of the company are necessary, and with this object resolutions will be submitted for approval at an extraordinary general meeting which will be held immediately after the ordinary meeting. In consequence of the high price of coal there has been a considerable increase in the cost beyond the provision made in 1899 to meet the expected extra outlay. An appreciable diminution in the revenue per unit sold has also been caused by the reduction in the price of the unit to consumers on the 200-volt supply, which it was deemed advisable to make in the latter part of 1899. This reduction has, however, been gradual, as it depended on the change by consumers to the higher pressure; it has resulted in bringing increased custom and inducing a somewhat freer use of the current. The number of lamps connected on December 31st, 1900, was 145,277, an addition of 6,410 during the year. The sum of £3,000 has been added to the renewals and depreciation fund, out of the net revenue. After deducting this amount, and after payment of interest on debenture stock (£6,750), there remains a balance of £11,370 17s. The directors recommend that this balance shall be applied as under:—

Interim dividend of 6 per cent. per annum on the preference shares for the half-year to June 30th, 1900 (paid July 1st, 1900)	£900 0 0
Interim dividend of 5 per cent. per annum on the old ordinary shares for the half-year to June 30th, 1900 (paid July 1st, 1900)	4,250 0 0
Dividend of 6 per cent. per annum on the preference shares for the half-year to December 31st, 1900	900 0 0
Dividend of 6 per cent. per annum on the old ordinary shares for the half-year to December 31st, 1900, making a total dividend of 5½ per cent. for the year	5,100 0 0
Dividend of 5½ per cent. per annum on the 9,805 new ordinary shares from the due dates of the instalments to December 31st, 1900	99 0 0
Amount carried forward to next account	121 17 0
	£11,370 17 0

The retiring directors, Mr. Nugent Daniell and Mr. George N. Marten, are eligible for re-election. The auditors, Messrs. Cooper Brothers & Co., offer themselves for re-election.

The annual meeting will be held on March 6th at the Town Hall, Chelsea. An extraordinary general meeting will follow for the purpose of approving certain alterations in the articles.

Telegraph Construction and Maintenance Company, Limited.

Sir Robt. Herbert presided at the annual meeting of this company held at 38, Old Broad Street, on Tuesday. In moving the adoption of the report, which appeared briefly in our last issue, he said that the directors had great pleasure in placing before the shareholders an account of a very much extended sphere of operations, resulting in very much larger figures than had appeared in any of the company's balance-sheets for a great many years past.

The net profit for the year was £100,195, and last year it was £92,348. The dividend and bonus for the year had been altogether 17½ per cent., leaving £75,564 to be carried forward. The balance-sheet showed that the totals had at last reached the sum of £2,000,000 on each side. They had been very actively at work during the year, and had done a great deal of good work in the way of laying cables, performing repairs for foreign Governments and companies, and providing store cable for companies to keep in stock. The factories were fully occupied, and were in an excellent condition. The Wharf Road factory had been somewhat further extended and furnished with fresh machinery. The reserve fund had been considerably increased. That would be found to be desirable when they bore in mind that they had been able to obtain the execution of the great Pacific cable, which would naturally entail upon them a heavy outlay before the company could receive the corresponding amount of pay for that work. The cable had to be completed by the end of 1902, and the smaller portions by the middle of 1902, so that they had a long period of work and expenditure to go through before they received the full remuneration which that work would bring when completed. For that reason it was desirable that they should have their pockets full of money ready to meet all the expenses of that trying period. The board had increased the pension fund by a further £10,000, making £20,000 in hand to organise that fund for their officers. The ships were all in excellent condition, and had been actively employed in various directions. They had all done good work. The *Anglia*, as usual, had almost exceeded her previous work. She was always doing record work in cable-laying. After paying a tribute to the good work done by their officers on ships, and officials in factories, he moved the adoption of the report.

Sir James Pender seconded, and it was carried unanimously, as were also the declaration of dividend, re-election of directors and auditors, and a vote of thanks to the board and staff.

Stock Exchange Notices.—The Committee have (1) appointed a special settling day as under:—Wednesday, March 6th—Brisbane Tramways Investment Company, Limited—75,000 ordinary shares of £5 each, fully paid, Nos. 1 to 75,000, 75,000 5 per cent. cumulative preference shares of £5 each, fully paid, Nos. 1 to 75,000, and provisional certificates (fully and partly paid) for £400,000 4½ per cent. first debenture stock; and has ordered same to be officially quoted.

The Western Telegraph Company, Limited.—The directors have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income-tax, for the quarter ended December 31st last, and payable on March 25th. The transfer books will be closed from March 18th to 23rd, both days inclusive.

United Alkali Company, Limited.—The United Alkali Company recommend the distribution of the full dividend of 7 per cent. on the preference shares, carrying about £60,000 forward. For the year 1899 the same dividend was paid on the preference, but the balance forward was only £36,800.

Northern Counties Electricity Supply Company, Limited.—Letters of allotment and regret have been posted.

TRAFFIC RECEIPTS.

Blackburn Corporation Tramways.—The receipts for the week ending February 22nd were £400 9s. 9d.; corresponding week last year, £359 17s. 2d.; increase, £40 12s. 7d. Total to date, £2,980 17s. 2d.; corresponding period last year, £2,652 3s. 8d; increase, £328 13s. 6d. Miles open, 8½.

Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending February 23rd were £139; corresponding week last year £143; decrease, £4. Total to date, £1,089; corresponding period last year, £1,112; decrease, £23.

Bristol Tramways and Carriage Company.—The receipts for the week ending February 23rd were £3,462 7s. 7d.; corresponding period last year, £2,648 16s. 2d.; increase, £813 11s. 5d.

Central London Railway.—The receipts for the week ending February 23rd, were £5,941; previous week, £6,131; decrease, £190. Total receipts to date (8 weeks), £48,779. Miles open, 6.

City and South London Railway.—The receipts for the week ending February 24th were £2,048; corresponding week last year, £1,115; increase, £933. Total to date, £16,088; corresponding period last year, £9,014; increase, £7,074. Miles open, 1901, 4½; 1900, 3⅝.

Dover Corporation Tramways.—The receipts for the week ending February 23rd were £145 14s. 3½d.; corresponding week last year, £141 5s. 8d.; increase, £4 8s. 7½d. Total to date, £1,714 17s. 10½d.; corresponding period last year, £1,170 0s. 10d.; increase, £44 17s. 0½d. Miles of track open, 3. Car miles run, 1901, 4,980; 1900, 4,866. Number of cars, 11.

Dublin United Tramways Company.—The receipts for the week ending February 22nd were as follows:—D. U. T. Co., electric cars, £2,932 7s. 3d.; D. S. D. Co., electric cars, £641 16s. 3d.; total £3,574 3s. 6d.; corresponding week last year—D. U. T. Co., electric cars, £2,880 7s. 7d.; ditto, horse cars, £50 19s. 7d.; D. S. D. Co., electric cars, £613 5s. 1d.; total, £3,544 12s. 3d.; increase, £29 11s. 3d.; aggregate to date, £28,779 18s. 1d.; aggregate to date last year, £26,110 7s. 5d.; increase, £2,669 10s. 8d. The mileage worked is 45 miles electrically, as against 42 miles electrically, 2 miles by horses, for the corresponding period last year.

Liverpool Overhead Railway.—The receipts for the week ending February 24th were £1,420; corresponding week last year, £1,360; increase, £60. Total to date, £11,757; corresponding period last year, £11,500; increase, £257. Miles open, 6 miles 57 chains.

STOCKS AND SHARES.

Wednesday Evening.

The firm front presented during the last three weeks by the electrical markets is still in evidence, and the volume of business continues satisfactory. There is a very fair amount of investment buying going on in manufacturing shares, and the supply market is attracting attention. Telegraph stocks are generally a shade lower, but traction shares are harder, and a new circle of investors has been drawn to this department in consequence of the new financial backing secured by the British Electric Traction Company.

In the supply market another rise of 10s. has lifted Metropolitans to 13½, the report being regarded in the market as exceedingly good. We outlined its principal features last week. Quite a different document is the Chelsea report, which shows that the company is making comparatively slow progress. The Ordinary shares mark a rescission of 5s., but the Preference are unaltered. City of London shares have become very nearly unmarketable, last week's adverse decision against the company having induced a number of small sales. In the Stock Exchange the result of the company's appeal was considered a foregone conclusion, but that did not avail to prevent a very uneasy tone setting in amongst the dealers when the decision was made known. The latest issue of City of London Debenture stock is quoted 101 to 103, and the price of new Westminsters is now on a par with that of the senior shares.

Telegraph securities are depressed in consequence of renewed fears as to Signor Marconi's inventions. Commercial Cable stock has been the worst sufferer. It is dealt in by the American Railroad market, where the idea of Marconi's competition ever becoming serious is scoffed at by the dealers. Of course, the stock stands at a fairly steep figure, which makes a fall all the more easily brought about. Anglo-American stock declined earlier in the week, but recovered part of the fall on the opening of a new office in Shorter's Court, Throgmorton Street. The first day's business proved good, and the additional office should prove a remunerative source of income. The Far Eastern division is very steady, Eastern Ordinary losing a point after its recent remarkable rise, but there is no change to record in "Chinas." Globe Telegraph shares are both ¼ lower, ostensibly on the Marconi scare, which has been absurdly overdone. Marconi shares, by the way, are 3¼ to 3⅜, and a very limited market at that.

The electrical railway department is exceedingly quiet, but the vibration trouble it is expected in Capel Court will turn out to be an unexciting matter after all, and the general opinion is that the company will not have to pay much, if anything, for compensation. Of more consequence are considered the proposals now being put forward to make more stringent regulations for electric railway enterprise. At Hammersmith they are pointing out the spot at which the latest "Tube" is to be constructed, which, its supporters say, will take all the passengers still left to the Metropolitan and District Railway Companies. But perhaps the scheme will never get beyond its primal stage. Metropolitan and District Stocks are quite indifferent to the coming change of traction on the lines: the market in both is a shade harder in sympathy with the better tone prevailing in the home railway section as a whole.

The latest issue of British Electric Traction Preference is quoted at ¼ premium. As we observed last week, at that figure the shares are a good investment of the second-class. At 5s. premium, the shares cost an investor £11 15s. each, being offered at an original premium of 30s. per share. The company has now a new financial coterie to which to look for support, Messrs. J. S. Morgan & Co. being one of the guaranteeing firms for the new issue. The Stock Exchange dealers are feeling somewhat hurt that the business should not have been offered to them first, as they had consistently supported the company all through, but probably the directors preferred to introduce new blood to their concern, and perhaps the step is a politic one. Anyway, the Ordinary shares are £1 better on the week, the Preference being unchanged. Some buying of Buenos Ayres and Belgrano Preference shares of both classes has taken place, the traffic being very good.

In the manufacturing division Callender's and Henley's easily captured the principal honours, with rises of £2 and 10s. respectively. The capital dividend declared by Henley's is encouraging very optimistic hopes as to the Callender announcement, expected in a few weeks' time. In fact, the buying has been of a character that seems to point to someone already possessing an inkling of what the dividend may be. Telephone shares are flat, and the National Company's meeting did nothing to shake the depression which has settled over this section.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotation Feb. 20th.	Closing Quotations Feb. 27th.	Business done during week ended Feb. 27th, 1901. Highest	Lowest.
96,900	African Direct Telegraph, 4 % Debs.	100	...	...	...	99 —102	99 —102	...	...
119,700	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red. ...	100	...	...	...	60 — 70	55 — 65	...	...
822,700	Anglo-American Telegraph	Stock	£3 9s.	73/6	3½%	53 — 56 xd	52 — 55	52½	51
3,088,540	Do. do. 6 % Pref.	Stock	6 %	6 %	6 %	98 —100 xd	97 — 99	98½	97
3,088,540	Do. do. Deferred	Stock	18s. %	£1 7s.	5s.%	8½— 9 xd	8¾— 9½	8¾	8⅝
44,000	Chili Telephone, Nos. 1 to 44,000	5	3 %	4 %	...	3 — 3½	3 — 3½	...	...
13,333,300§	Commercial Cable	$100	8 %	8 %	...	170 —180	165 —175	...	...
1,589,496/	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	102 —104	102 —104	103½	...
16,000	Cuba Telegraph	10	8 %	7 %	...	8 — 9	7½— 8½	...	...
6,000	Do. 10 % Pref.	10	10 %	...	...	16 — 17	16 — 17	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	...	3½— 4½	3½— 4½	...	...
6,000	Do. do. 10 % Cum. Pref. ...	5	...	...	...	9 — 10	9 — 10	...	...
30,000	Do. do. 4½ % Debs.	50	...	...	...	100 —104%	100 — 104%	...	...
60,710/	Direct United States Cable	20	3½%	3 %	3 %	10 — 10½	10 — 10½	10	...
108,300	Direct West India Cable, 4½ % Reg. Deb. ...	100	...	...	...	99 —102	99 —102	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	...	146 —151	145 —150	147½	145
1,826,888	Do. 3½ % Pref. Stock	100	...	...	...	95 — 98	95 — 98	96½	95
1,432,268/	Do. 4 % Mort. Deb. Stock Red.	Stock	...	...	...	113 —117	113 —117	113	...
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	...	14½— 14⅝	14½— 14⅝	14⅝	14½
50,000	Do. Nos. 250,001 to 300,000 (iss. at £3 pm. all pd.) ...	10	...	...	...	13⅝— 14½	13⅝— 14½	14	13⅝
320,000/	Do. 4 % Deb. Stock	Stock	...	...	...	110 —115	110 —115	...	...
300,000/	Eastern and South African Telegraph, 4 % Mort. Deb. Nos. 1 to 3,000, red. 1909	100	...	...	...	99 —102	99 —102	...	...
200,000/	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	...	...	...	101 —104%	101 —104%	...	...
180,227	Globe Telegraph and Trust	10	5½%	5½%	...	10 — 10½	9⅝— 10⅛	9 1/16	9⅛
180,042	Do. do. 6 % Pref.	10	6 %	...	...	15 — 15½	14⅝— 15½	15½	14 3/16
150,000	Great Northern Telegraph, of Copenhagen	10	12½%	...	...	32 — 34	32 — 34	32⅝	...
82,000	Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	99 —102	99 —102	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	...	47 — 51	47 — 51	...	...
100,000/	London Platino-Brasilian Telegraph, 6 % Debs.	100	...	...	...	104 —107	104 —107	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680 ...	1	...	2½%	...	¾— ⅞	¾— ⅞	...	...
86,492	Do. do. 5 % Pref., Nos. 1 to 86,492	1	4 %	5 %	...	¾— 1	¾— 1	...	...
590,000	National Telephone, 1 to 590,000	5	6 %	5 %	5 %	3⅜— 3⅞	3½— 3⅝	3⅝	3⅜
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	12 — 14	12 — 14	13	12½
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	11 — 13	11 — 13	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	4⅞— 5⅛	4⅝— 5	4 1/16	4¾
2,000,000/	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	94 — 97	94 — 97	95⅝	94
500,000	Do. 4 % Deb. Stock Red.	100	...	...	4 %	98 —101	98 —101	100	98
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	...	⅞— 1⅛	⅞— 1⅛	⅞	...
100,000/	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	...	...	...	99 —102	99 —102	...	...
11,839	Reuter's	8	5 %	5 %	...	7½— 8½	7½— 8½	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	124 —129	124 —129	...	...
58,000	United River Plate Telephone	5	6 %	7 %	...	4½— 5	4½— 5	...	...
40,000	Do. do. 5 % Cum. pref. Nos. 1—40,000	5	...	...	...	4⅝— 5⅛	4⅝— 5⅛	...	...
179,947	Do. do. 5 % Debs.	Stock	...	...	...	103 —106	103 —106	...	...
171,000	West African Telegraph, 5 % Debs....	100	...	...	...	99 —102	99 —102	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	¼— ⅜	¼— ⅜	...	...
150,000	Do. do. 4 % Debs., 1—1,500 gua. by Braz. Sub. Tel.	100	...	...	...	99 —102	99 —102	100	...
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	...	13⅜— 14¼	13⅜— 14¼	14 3/16	13⅞
75,000	Do do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	101 —104	101 —104	...	...
348,777	Do. do. 4 % Deb. Stock Red.	100	...	...	...	102 —105	102 —105	...	...
88,321	West India and Panama Telegraph	10	2 %	6%	...	⅝— ¾	⅝— ¾	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	...	...	...	6 — 7	6 — 7	6½	...
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	...	...	...	5 — 7	5 — 7	...	...
80,000/	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	...	...	...	103 —106	103 —106	103	...

ELECTRICITY SUPPLY COMPANIES.

19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	6 %	6 %	6 %	7½— 8½	7½— 8½	...	...
12,000	Do. do. 7 % Cum. Pref....	5	...	...	...	8½— 9½	8½— 9½	...	...
50,000	Charing Cross and Strand Electricity Supply	5	8 %	9 %	9 %	9½— 10½	9½— 10½	...	...
20,000	Do. do. do. do. 4½% Cum. Pref.	5	...	...	...	5½— 5⅝	5½— 5⅝	...	...
34,000	*Chelsea Electricity Supply, Ord.	5	6 %	6 %	5½%	6½— 7	6½— 6⅝	6⅝	6½
150,000	Do. do. do % Deb. Stock Red. ...	Stock	...	...	...	109 —112	109 —112	...	...
70,579	City of London Electric Lighting, Ord. 40,001—110,579...	10	6 %	4 %	...	7 — 8	7 — 8	7⅞	7½
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	...	...	13 — 14	13 — 14	...	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	...	...	...	122 —127	122 —127	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	nil	4 %	...	8½— 9½	8 — 9	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	...	...	11½— 12½	11½— 12½	11⅞	...
200,000	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd. ...	...	...	...	...	106 —109	106 —109	107½	107
35,500	Edmundson's Elec. Corp., Ord. Shares	5	7 %	...	...	4½— 5	4⅝— 5⅛	4 1/16	...
75,000	Do. do. 4½ % 1st Mort. Deb. Stock. ...	100	...	...	...	103 —106	103 —106	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	1½— 2	1½— 2	...	...
49,840	Do. do. do. do. 6 % Pref.	5	6 %	...	...	4 — 5	4 — 5	...	...
250,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	98 —101	98 —101	99½	99
85,000	Metropolitan Electric Supply, 101 to 62,500	10	5 %	5 %	6 %	12½— 13½	13 — 14	13 1/16	13½
220,000/	Do. 4½% First Mortgage Debenture Stock	...	...	...	...	110 —113	110 —113	...	...
250,000	Do. 3½% Mort. Deb. Stock Red.	Stock	...	...	...	96 — 99	96 — 99	99	...
6,452	Notting Hill Electric Lighting	10	6 %	7 %	...	15½— 16½	15½— 16½	...	...
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½ %	14 — 15 xd	14 — 15	14⅝	14½
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8½— 9½	8½— 9½	...	...
150,000	Do. do. 3½ % Deb. Stock Red. ...	100	...	...	...	98 —101	98 —101	100	...
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	2 — 2½	2 — 2½	...	...
50,000	Do. do. 4 % Deb.	100	...	...	...	80 — 90	80 — 90	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	2½— 3½	2½— 3½	...	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000... ...	5	12 %	13 %	10½ %	12 — 13	12 — 13	12⅞	12 7/16

* Subject to Founders Shares.
Unless otherwise stated all shares are fully paid.
Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

Quotations on Liverpool Stock Exchange.
§ Dividends paid in deferred share warrants, profits being used as capital.

SHARE LIST OF ELECTRICAL COMPANIES.—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotation Feb. 20th.	Closing Quotation Feb. 27th.	Business done week ended Feb. 27th, 1901. Highest	Lowest
		‡							
20,000	British Aluminium 7 % Cum. Pref.	10	...	...	...	8 — 9	8 — 9	...	...
300,000	Do. do. 5 % 1st Mort. Deb. Stock Red. ...	Stock	...	...	...	91 — 95	91 — 95	...	...
45,000	British Electric Traction	10	6 %	...	...	13½ — 14½	14½ — 15½	15	14½
50,000	Do. do. 6 % Cum. Pref.	10	...	...	...	11½ — 12½	11½ — 12½	12⅝	12 5/16
350,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	120 —123	120 —123	121½	121½
85,000*l*	†British Electric Works Co., Ord. £1 shares, 50,001—135,000	...	...	...	...	1/16 — 3/16	1/16 — 3/16	...	...
50,000	† Do do. 6 % Cum.Pref., 1—50,000 ...	...	...	...	...	3/8 — 1/4	3/16 — 5/16	...	...
500	† Do. do. 4½ % 1st Mort. Deb.	100	...	...	...	85 — 90	85 — 90	...	...
70,000	British Insulated Wire Ord.	5	15 %	20 %	15 %	11 — 12	11 — 12	...	...
70,000	Do. do. 6 % Cum. Pref.	5	...	...	...	5⅝ — 6½	5⅝ — 6½	6	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	2	5 %	6 %	...	1⅝ — 1⅞	1⅝ — 1⅞	1⅞	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000 ...	2	6 %	6 %	...	2⅛ — 2⅜	2⅛ — 2⅜	2 1/16	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock	Stock	...	...	...	105 —110	105 —110	109½	108
108,710	Do. do. 4½ % Perp. 2nd Deb. Stock ...	Stock	...	...	...	101 —103	101 —103	...	...
30,000	Callender's Cable Construction shares, Nos. 1—30,000 ...	5	15 %	15 %	...	13½ — 14½	15½ — 16½	16½	13⅞
40,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5⅛ — 6	5⅛ — 6	5 1/16	5½
90,000	Do. do. 4½ % 1st Mort. Deb. Stock Red ...	Stock	...	...	...	109 —113	109 —113	...	...
206,297	Central London Railway, Ord. Shares	10	...	...	...	9½ — 9⅝xd	9 — 9⅛	9⅝	9¼
78,703	Do. do. Pref. half-shares	5	...	...	...	4⅝ — 5¼xd	4⅝ — 5¼	...	...
78,703	Do. do. Def. do.	5	...	...	...	4 — 4¼xd	4 — 4¼	4⅛	...
855,000	City and South London Railway	Stock	2⅛%	1⅞%	1¼%	46 — 50 xd	46 — 50	49¼	...
37,500	Do. do. Ord. shares Nos. 22,501 to 60,000	10	...	...	...	4 — 5 xd	4 — 5	4½	...
54,000	Crompton & Co., Nos. 1 to 54,000	3	6 %	7½%	...	3¼ — 3⅝	3¼ — 3⅝	...	...
100,000	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red	...	...	...	...	100 —103	100 —103	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	6 %	...	1½ — 2	1½ — 2	...	...
17,139	Do. do. do. "A" Shares, 01—017,139 ...	5	6 %	6 %	...	3½ — 4⅛	3½ — 4⅛	...	...
344,023	Do. do. do. 4 % Deb. Stock Red ...	100	...	...	...	88 — 90	88 — 90	...	...
100,000	Do. do. 5% 2nd Deb. Stock Prov. Certs. all pd.	100	...	...	...	96 —100	96 —100	...	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	...	1¾ — 2⅛	1¾ — 2⅛	2	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000... ...	2	7 %	...	...	2⅛ — 3	2⅛ — 3	...	...
182,500	Do. do. 4 % Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	101 —104	101 —104	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600	10	7 %	7 %	...	10 — 11	10 — 11	...	...
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	14 %	15 %	20 %	15½ — 16⅛	16 — 17	16⅝	16¼
35,000	Do. do. do. 4½ % Pref.	5	7 %	...	...	5½ — 6	5½ — 6	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	...	...	...	108 —112	109 —113	113	110
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	...	20½ — 21½	20½ — 21½	20⅝	...
300,000	Do. do. do. 4 % 1st Mort. Deb	100	...	...	...	101 —104	101 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	3½%	3⅝%	3¼%	8 1/16 — 8 3/16	8 — 8⅛	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5	...	13 — 13¼	13 — 14	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	17½%	41 — 45	41 — 45	41¼	41
150,000	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...	...	101 —104	101 —104	...	...
20,000	Telegraph Manufacturing, Ord. Nos. 1 to 20,000	5	8 %	12 %	...	11 — 12	11 — 12	11⅜	11
20,000	Do. do. 5 % Cm. Prf. Nos. 1 to 20,000...	5	...	...	...	5½ — 6	5½ — 6	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	3 %	3 %	3 %	93 — 96 xd	93 — 96	...	...

† Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Brompton and Kensington, 4½ % Debentures of £100, 101—104.
Consolidated Telephone Construction and Maintenance, 3/—4/-
National Electric Free Wiring, 12/6 paid, 3/16—1/8.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 15½—16½.
Do. do. Pref. (£10 pd.), 10—10½.

* From Birmingham Share List.

Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 11—12; 1st Preference Cumulative 6 % £5 (fully paid), 6½—7 Debentures, 101—104. Dividend, 1900, on Ordinary Shares 12 %.
*T. Parker, £10 (fully paid), 16½.

Bank rate of discount 4 per cent. (February 21st, 1901).

MARKET QUOTATIONS, Wednesday, February 27th.

CHEMICALS, &c.		This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a „ Nitric	per cwt.	22/-	22/-	..
a „ Oxalic	per cwt.	32/-	32/-	..
a „ Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	39/-	39/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33 10	£33 10	..
a „ „	per ton	£30	£30	..
a Bleaching powder	per ton	£7	£7	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£17 10	£17 10	..
a Bensole (90 %)	per gal.	7/-	7/-	..
a „ (50/90%)	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£25	£25	..
a Lead, Nitrate	per ton	£25	£25	..
a „ White Sugar	per ton	£31	£31	..
a „ Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160° C).	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks..	per lb.	3½d.	3½d.	..
a „ Caustic (75/80%) ..	per ton	£24	£24	..
a „ Bisulphate	per ton	£35	£35	..
a Shellac	per cwt.	64/-	64/-	..
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6	£6 5s.	..
a „ Recovered	per ton	£5 10	£5 10	..
a „ Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	£10 15	..
a „ Crystals	per ton	£3	£3	..
„ Bichromate, casks ..	per lb.	2¾d.	2¾d.	..
METALS, &c.				
b Aluminium Wire, in ton lots..	per ton	£224	£224	..
b „ Sheet, in ton lots	per ton	£191	£191	..
p Babbitt's metal ingots.. ..	per ton	£80 to £145	£80 to £145	..
c Brass (rolled metal 2" to 12") basis	per lb.	7¾d.	7¾d.	..
c „ Tube (brazed)	per lb.	10d.	10d.	..
c „ „ (solid drawn) ..	per lb.	8½d.	8½d.	..
c „ Wire, basis	per lb.	8½d.	8½d.	..
c Copper Tubes (brazed) ..	per lb.	11d.	11d.	..
c „ „ (solid drawn) ..	per lb.	10¾d.	10¾d.	..
g Copper Bars (best selected) ..	per ton	£86	£86	..

METALS, &c. *(continued.)*		This week	Last week.	Inc. or Dec.
g Copper Sheet	per ton	£86	£86	..
g „ Rod	per ton	£86	£86	..
e „ (Electrolytic) Bars ..	per ton	£82	£82	..
e „ „ Sheets ..	per ton	£90	£90	..
e „ „ Rod ..	per ton	£84	£84	..
e „ „ H.C. Wire	per lb.	9¼d.	9¼d.	..
f Ebonite Rod	per lb.	8/-	8/-	..
f „ Sheet	per lb.	5/-	5/-	..
n German Silver Wire	per lb.	1/6	1/6	..
h Gutta-percha fine	per lb.	8/-	8/-	..
h India-rubber, Para fine	per lb.	8/10½	8/8	2½d. inc.
i Iron, Charcoal Sheets	per ton	£18	£18	..
i „ Pig (Cleveland warrants) ..	per ton	46/8	46/7	4d. dec.
i „ Forgings, according to size	per ton	From £11	From £11	..
i „ Scrap, heavy	per ton	70/- to 72/6	70/- to 72/6	..
i „ Wire, galvanised No. 8 ..	per ton	£10 5	£10 5	..
g Lead, English Ingot	per ton	£14 10	£14 17 6 to £15 2 6	7/6 dec.
g „ „ Sheet	per ton	£17 15	£17 15	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bot.	£9 2 6	£9 2 6	..
d Mica (in original cases), small ..	per lb.	3d. to 9d.	3d. to 9d.	..
d „ „ „ medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d „ „ „ large ..	per lb.	3/3 to 7/3	3/3 to 7/3	..
p Phosphor Bronze, plain castings	per lb.	1/0½ to 1/3	1/0½ to 1/3	..
p „ rolled bars & rods	per lb.	1/1 to 1/4	1/1 to 1/4	..
p „ „ strip & sheet	per lb.	From 1/8	From 1/8	..
o Platinum	per oz.	£4	£4	..
p Silicium Bronze Wire	per lb.	10¾d. to 1/½	10¾d. to 1/1	..
i Steel, Magnet, acc'd'ng to desc'p'n	per ton	From £15	to £40	..
i „ „ in bars		£58	£58	..
g Tin, block	per ton	£125 10 to £126 10	£125 10 to £126 10	..
g „ foil	per lb.	1/6	1/6	..
n „ wire, Nos. 1 to 16	per lb.	1/9	1/9	..
p White Anti-friction Metals — "White Ant" brand	per ton	£40 to £70	£40 to £70	..
j Yarns, Cotton, Single 10 lb. b'ndl's	per lb.	9¼d.	9¼d.	..
j „ Best Flax, 6 lea.	per lb.	6d.	6d.	..
j „ Hemp, 3 ply 10 lbs. ..	per lb.	4¾d.	4¾d.	..
j „ Russian, 10 lbs. ..	per lb.	5¾d.	5¾d.	..
j „ Jute, 180 lbs. rove	per ton	£14 10	£14 10	..
k Zinc, Sh't. (Vielle Montagne and.)	per ton	£21 12 6	£21 12 6	..

Quotations supplied by
a Messrs. G. Boor & Co.
b The British Aluminium Co., Ltd.
c Messrs. Thos. Bolton & Sons.
d Messrs. F. Wiggins & Sons.
e Messrs. Frederick Smith & Co.

Quotations supplied by
f India-Rubber, G.-P. and Teleg. Works Co., Ltd.
g Messrs. James & Shakespeare.
h Messrs. Jackson & Till.
i Messrs. Bolling & Lowe.
j Messrs. Henry C. Yeo & Co.

Quotations supplied by
k Messrs. Morris Ashby, Limited
m Messrs. W. T. Glover & Co., Ltd.
n Messrs. P. Ormiston & Sons.
o Messrs. Johnson, Matthey & Co., Ltd.
p The Phosphor Bronze Company, Ltd.

ELECTRICAL POWER IN BRITISH WORKS.

Read before the Gloucester Engineering Society, February 19th, 1901, by

W. GEIPEL, M.I.E.E.

(*Concluded from page* 342.)

I now come to the question of the generators, which involves the consideration of the relative methods of the continuous and alternating current. I do not think it possible to lay down a hard and fast rule as to the selection, beyond stating that the two most suitable for a works are the 2-wire continuous current system and the 3-phase system, using Star winding, so that lamps may be connected between the neutral wire and the phase wires.

There is little or nothing to choose between the two systems on the score of efficiency, so far as concerns the percentage of power lost in the transmission. The continuous current is probably more suitable for small works, where the number of motors is few, and the commutators of less importance. For larger works there are advantages in the use of the 3-phase system, which should certainly be carefully considered. In the first place the generator itself is more mechanical, the current passes direct from the winding of the armature through bound terminals to the conducting cables. There is no commutator required beyond that on the exciter, which has to deal with less than 5 per cent. of the total current. The heavy armature bars and connections are stationary, and there is not, therefore, the same difficulty in effectually insulating them, as is found in the case of continuous current generators.

The regulation of continuous current generators is generally done by compound winding. Three-phase generators have also been so arranged, but for the latter I prefer to make use of an automatic regulator. That known as the Chapman Regulator acts admirably, and is in use, amongst other places, at the Bristol Waggon Works. It consists of a series of contacts, over which a slider is moved by means of a solenoid, excited by current taken from the exciter. This solenoid is controlled by a relay placed in the main circuit, which actuates the solenoid according as the voltage is above or below normal. I should mention that the solenoid is designed specially to annul all sparking at the relay contacts. There appears to be no difficulty with this device in automatically maintaining the voltage within 1 per cent. up or down.

Some point has recently been made of the fact that provision shou'd be made in alternating generators for the extra current due to the power factor of the motors. This, however, is always duly provided for by makers of 3-phase machinery. There is no difficulty whatever in doing it, and it does not add to the expense where the power factor is a normal one. Usual'y, the generators are wound for a factor of ·8.

As to the conducting cables for power circuits, there is no difference between the continuous current and the 3-phase current as to the quantity of copper, with this exception, the voltage is generally settled in order that the lighting of the works may be done from the same plant, which necessitates that the voltage between the lighting wires shall not exceed about 200. In the case of the 3-phase, this would be the voltage between the neutral and the phase wires; consequently the voltage across the phase wires would be 350. By virtue of this, for the same percentage of loss the quantity of copper in the case of the 3-phase motors would be less than half that on the continuous system. On the other hand, it is possible to effect an economy in this respect in the case of the continuous current by using 3 wires and 400 volts. This, however, involves the use of two generators, or, at any rate, two commutators and armature windings on one generator; otherwise, as is now more general, an external balancing dynamo motor—complications which in the case of the 3-phase are not necessary. I may mention here that in the Bristol Waggon Works, where my firm fixed up a 3-phase installation, I found that by making the worst condition of balance, viz., by switching in all the lamps on one phase, and none on the other two, that the difference in the lighting effect could not be observed; it was only between 2 and 3 per cent.

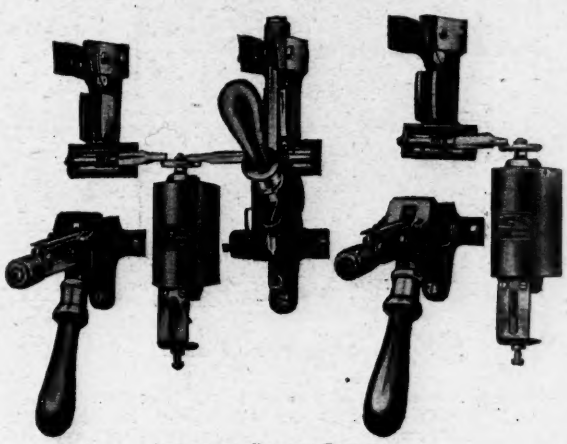
It is sometimes urged as an objection to the 3-phase system that, instead of having two conductors to run, there are three. I have not found this any disadvantage whatever, while for the larger motors it is really an advantage to be able to run three small instead of two heavy cables.

As to the motors, it appears to be generally admitted that the 3-phase induction motor is of a stronger mechanical design, more particularly in the revolving parts. The current in the revolving part has no electrical connection with the circuit. It may have a very low tension, thus rendering the insulation of the winding more permanent. In the case of the continuous current motor, there is not only the commutator difficulty, but the rotating armature must be wound with a large number of small windings, and must be insulated to stand the full pressure of the supply. The only part of the 3-phase motor which is in connection with the supply, and therefore has the full pressure, is the stationary winding; this, like the generator, is connected to the circuit through bound and insulated terminals; there is no point therefore in the circuit, either at the generator or motors, which is exposed to the touch of workmen.

Either system can be used for working at constant speed or at variable speed. In the case of variable speed, where large torque is required at low speeds, the continuous current series wound motor is, perhaps, more suitable; if it is not a desideratum that the torque should be largely increased, then the 3-phase motor is equally suitable, and it has the additional advantage that the speed controlling apparatus has no connection with the main circuit, while, in the case of the continuous current, the controller must be carefully designed and operated on account of its being in the main circuit, and subjected to the full pressure thereof. I may mention in this connection that my firm have supplied to the Patent Shaft and Axletree Company a dozen motors of 20-H P. each for operating their various heavy cranes, the motors being used at variable speeds with the controlling apparatus in the rotor circuit.

There is a further advantage which may be claimed for the 3-phase motor and that is that temporary overloading has no deleterious effect, and where the load is unduly increased, such as it may be by hot bearing or breakdown of a machine, the motor breaks out of step and the safety fuses blow, no damage being done. Overloading in the case of continuous current machines may damage the commutator and cause much trouble. It is stated that 90 per cent. of the repairs required by continuous current machinery are due to the commutators.

There is little to choose between the switching apparatus required by either system. For continuous current only two switches and fuses per feeder circuit are necessary, while for the 3-phase



Automatic Circuit Breakers.

three switches and fuses are required, but as these are for smaller currents there is little difference in the cost, if any. I have found it better to use the automatic circuit breaker, now commonly used in the United States, in place of the usual switch and safety fuse. When an abnormal load opens the circuit through the blowing of the ordinary safety fuse there is a delay caused in replacing the fuse; moreover, there is a tendency for workmen to replace with a fuse which is too large to be safe; this, of course, robs the circuit of its protection and frequently results in damage. An excellent circuit breaker at a reasonable price is made by the Ward Leonard Co., combining a hand operated switch with an automatic device for

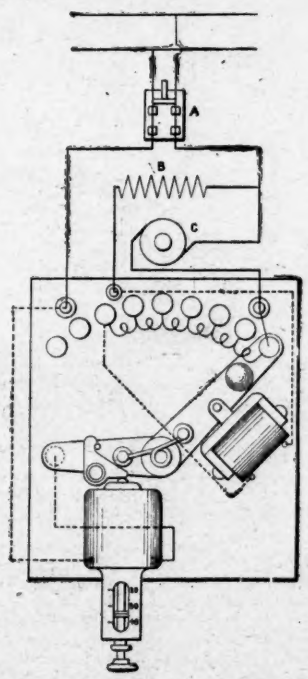
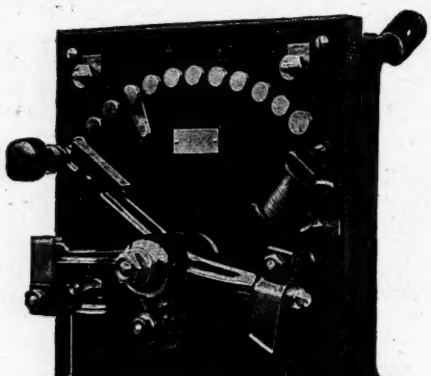


Diagram of Connections of Motor Switch.

opening the circuit which can be set to open at any prearranged current. Here are some samples of these circuit breakers; they are also shown in the illustration both single and double pole. After

acting the switch is always ready to be re-closed, and should it happen that the fault in the motor or its circuit remains the switch instantly re-opens. Only those who have had to replace large fuses appreciate fully the advantage of such a device. These circuit breakers are generally fixed on the main switch-board. At or near each motor it is customary to place the starting switch. For the 3-phase motor, with the exception of the larger sizes, nothing more is necessary than an ordinary switch and fuse, or a circuit breaker of the type above mentioned may be used. For the continuous current motor it is necessary to provide a starting resistance in addition. This resistance should be switched in gradually, otherwise damage may be done to the commutator by too rapid starting. Ward Leonard, who has given special attention

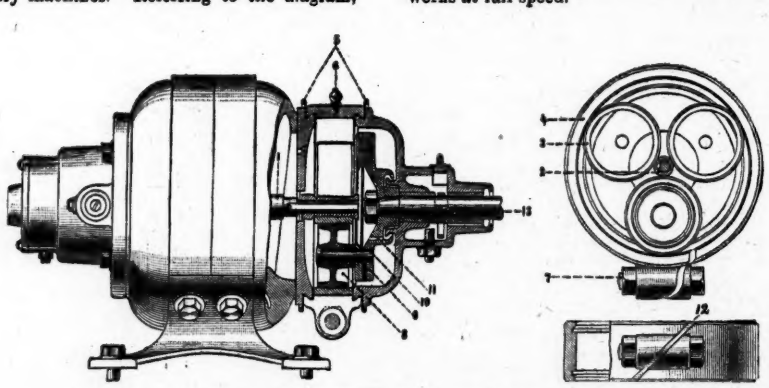


Ward Leonard Motor Switch.

to this subject, has designed what he terms a "fool-proof" motor switch. There is a sample "fool-proof" switch on the table, and I give an illustration showing the connections and outside appearance. It prevents the attendant from operating the resistance switch too rapidly, it opens the circuit if the current becomes excessive or if the voltage fails, even during the period of starting-up the motor, while in no case can the motor be restarted without first inserting the resistance. This is a desideratum, as the attendant is apt to forget to reinsert the resistance before re-starting and damage results.

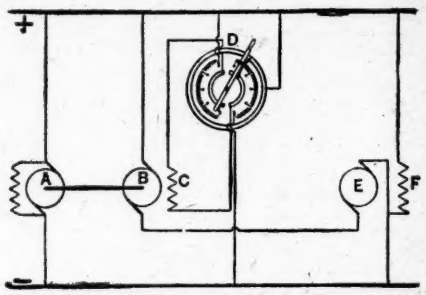
It has been urged against 3-phase motors that they run at a high speed. I have not, however, found their speed to be greatly different to the continuous current motors which I have installed; in some cases it is slower, in other cases faster. Of course, it is possible by extra expense to greatly reduce the speed of either form of motor, but the cost is prohibitive, so that it is usual to resort to some method of reducing the speed of the motor either by belting or gearing.

I have recently used a very neat and compact speed reducing gear which does away with belting and toothed gear. It is known as the Centrator gear, and has been for many years largely used for driving laundry and dairy machines. Referring to the diagram,



"Centrator" Speed Reducing Gear.

2 is a central roller on the motor shaft between which and the outer adjustable ring 12 the flexible steel rings 3 are pressed so that they become slightly oval. Inside of the rings are easy fitting rollers 8, these are pivotted to the disc 9 which is keyed to the slow-driven shaft. As the motor turns the roller 2 the steel rings rotate and carry with them the disc at the desired reduction in speed. Another very ingenious method of reducing the speed of motors, and at the same time of increasing the torque, has been invented by Ward Leonard. This system is more particularly suited to cases where the motor is required to work through very large ranges of speed, such as in printing, where, in setting the machine, it is usual to run it round at something like 1 per cent. of its full speed. To explain this system fully is beyond the scope of my paper; but I give an illustration showing one of his methods. The regulation is done without any resistance whatever in series with the motor, and the only resistance used is a small field rheostat, which, at the most extreme range, absorbs but 2 per cent. of the energy absorbed by the series resistance, while generally it absorbs much less. Further, it is provided with a large number of small contacts, so that in passing from one to the other there is not that jump in the speed which is so objectionable when using the ordinary resistance. + − are the supply mains; ABC is a motor generator, of which A is the small motor, B the generator armature, and C the generator field; D is a field rheostat for the generator; E is the armature of the driving motor, and F is the field thereof. The motor generator is one-half of the rated power of the driving motor. Each of the fields is excited directly from the mains independently of its armature. In series with the field C of the generator, there is inserted the rheostat D, which can be arranged for reversing, as shown in the figure. The motor generator runs at constant speed, but the voltage of the generator armature is varied according to the strength of its field C, so that



Ward Leonard System of Motor Regulation.

it can give any voltage from nothing up to its maximum, which, in the particular arrangement shown in the figure, is the same as that between the mains. This armature is connected in series with the armature of the driving motor E, so that the current used for driving the motor E always passes through the generator B. It will be seen that by operating the switch of the rheostat D, the generator B can be made either to assist or to oppose the voltage between the mains + and −; when it is fully excited, and opposing the main voltage, there is no difference of potential across the motor armature E, and this is the condition when starting. As the rheostat is gradually switched into circuit, the opposing voltage of generator B falls, and the armature of the driving motor E rotates at first very slowly, but the current passing may be the same as the maximum-load current, so that the torque at the starting may be a maximum.

The maximum torque, then, is obtained without a resistance in series with the motor armature, for the armature B of the generator has merely a back electromotive-force action, which absorbs no energy. As the rheostat is still further switched out of circuit, the opposing electromotive force of the generator B becomes less and less until it is zero, and the motor E is driven at half speed, having across its terminals the full voltage of the mains. Further, as the field rheostat is reversed and gradually switched out of circuit, the generator B begins to assist the voltage of the mains; and when the rheostat is finally switched out of circuit the generator B doubles the voltage of the mains, and the motor E works at full speed.

It will thus be seen that the armature of the motor E may always operate with its maximum current, while the voltage supplied thereto varies directly as the speed at which it is desired the motor shall be driven without the use of any resistance or energy-wasting device in circuit.

In addition to driving printing machinery, this system is used for large cranes, fast and heavy lifts, for naval purposes, such as training guns, haulage machinery, and various other purposes.

In conclusion, I will sum up the advantages of electricity apart from the efficiency of transmission, and the saving in power which in most machinery establishments would pay for the additional cost of the electric plant in from two to five years; they are:—

(1) Absence of overhead shafting, which requires special construction of shops, and causes vibration, dust and dirt.

(2) Absence of belts, dust arising therefrom, repairs necessary thereto and shadows.
(3) Clear head room for the use of electric cranes and hoists.
(4) Better light and cleanliness.
(5) Regularity of speed of machinery, and saving of wear and tear thereof.
(6) Placement of machinery to facilitate handling of work.
(7) Easy application of motors for special tools, such as key seating, cylinder boring, air compressing.
(8) Facility of running one or two machines without the rest for working overtime.
(9) Special suitability for working cranes and lifting apparatus.
(10) Ease of extension.
(11) Utility for electric lighting and other purposes.
(12) General flexibility of the system.
(13) Increased output.

INSTITUTION OF ELECTRICAL ENGINEERS (MANCHESTER SECTION).

ON THE TRAINING OF ELECTRICAL ENGINEERS.

By John T. Nicolson, D.Sc., M.Inst.C.E.

(*Paper read February 12th*, 1901.)

(*Concluded from page* 347.)

With regard to the one day per week of the student's last year which was told off for work in the electrical drawing office, my friend, Prof. E. B. Owens, of McGill College, has found it an excellent plan to take up the design of a complete line of machines to meet given commercial conditions. Each student takes one, and the advantage of having all the students in the class working on machines of the same type, but of different dimensions, is that by comparing notes they are able to see clearly the change necessitated in the dimensions, as the output or conditions of running vary.

A set of both direct and alternate current machines should always be taken up. A good plan is then to submit the data compiled and the drawings prepared, to the criticism of someone whose business it is to design machines for the maintenance of a reputation and the earning of an income on money invested in the manufacture of electrical machinery.

In this way the attempt may be made to impart to the student information possessing a real market value, without sacrificing the study of broad principles to unnecessary detail.

An important expedient for bringing the electrical engineering college into close contact with the ever varying practical development of the subject, is to obtain the services of specialists in the several fields of current work, in giving courses of lectures on the status and probable development of their special line of activity. Courses of from six to ten lectures each, upon which the student should be examined, as upon work given by the ordinary instructors, are best adapted for dealing with such special topics. One or two lectures by a distinguished engineer, although interesting, do not meet the requirement.

Another most important study which ought to be mentioned in this connection is what is called by the Germans, "Wirthschaftlichkeit," and which may perhaps be rendered the "economics of engineering design." Its object may be most easily explained by taking an example from the work of an American college which is due to my friend Prof. Owens.

It was required of every electrical engineering student in this college that, towards the end of his course, he should figure out the design of either a lighting or street railway plant. A number of scale drawings of towns of various sizes were available, and from known or assumed conditions the position of the station was assigned. Then, in the case of a lighting plant, the locations of the individual customers was taken as given, with particular load diagrams for each. From these isolated diagrams the nature of the station load was determined and the machinery and circuits laid out. All the circuits were calculated and were shown on the map, together with poles and the more important accessories. Outline plans for standard machines were readily obtainable, and the station was arranged by their aid. Full specifications for the plant were then drawn, definite as regarded the results to be obtained, but impartial as regarded different types of plant. Lastly, a bill of material was made out and the costs estimated for some one type of standard machinery, using price lists and allowing for labour; and the expense of operation and maintenance, together with the income necessary to render the installation a paying investment were determined. Such plans and estimates were then checked by a constructing engineer, whose business it was to be in touch with such matters.

This department of study, which really constitutes the daily duty of the designing engineer, has been to my knowledge almost wholly neglected in all save one or two German and American colleges. Such a worked out example as the above places in due perspective the relative value of the various portions of the pupil's whole curriculum. Hitherto we have mostly been content to discuss with all elaboration the design of our machines in regard to their general convenience and adaptation to their purposes, keeping in view simplicity and safety of operation, easiness of adjustment, and facility of repair; we have also exhaustively treated the elements of strength and rigidity, and the balancing of the rotating or other moving parts; in some instances the ideas of harmony of proportion and of elegance of detail have even been entered into; but very seldom have the really vital questions of cost of construction and total cost of production of different designs, in relation to the respective expenses of their maintenance for operation and for repairs, and of their durability, been duly approached in the professional college or school. Yet these are the governing factors in the everyday settlement of engineering problems!

The course of training for an electrical engineer, which has been somewhat hurriedly, and I fear incompletely, sketched in the above remarks, nevertheless outlines the curriculum which a not inconsiderable experience in such matters leads me to recommend as being best adapted—not in any sense to produce a complete electrical engineer—but to impart to a youth of moderate ability and unflagging devotion the capacity to follow with success that arduous calling. It must be recollected that the British engineer of the new century will need not only to know and to be able to use that which has been perfected by his predecessors, but to be continually experimenting and improving upon what already exists, to be devising new lines of activity, and to be discovering fresh fields of operation, if we are to maintain not merely our industrial supremacy, but even our national independence, in the tremendous struggle for commercial existence which is now impending.

In conclusion, I would press upon the members of this Institution the strong conviction I hold of the expediency, from the point of view just referred to, of at once establishing some arrangement whereby the more eminent young employés of our manufacturing houses may be enabled and encouraged to return, for periods of months at a time, to the laboratories of their schools or colleges for the purpose of spending their whole energies in the prosecution of industrial research for the benefit of the firms employing them. This system is already partly in vogue in Germany and America, and has produced most gratifying results. But this and all the other questions in regard to the proper education of our young engineers are entirely in the hands of their future employers. If the leaders of British industry do not realise the national significance of such higher scientific training as is here proposed, it is futile for the heads of our colleges and technical schools to seek to thrust forward their projects in their despite.

Discussion.

Mr. W. G. Rhodes said the disadvantage of the system of teaching in England was that the teachers for the most part were utterly practical men, whose ideas were to make the work as abstruse as possible rather than eliminate those mathematical matters which were positively disheartening to young engineers. Boys were—boys; they wanted pleasure as well as work, and they could not be expected to put in more than two or three nights a week attending classes. Two classes a week were quite enough for a youth to take up, one night laboratory and one night theory. He knew from experience that the attempt to crowd much into classes at night was fatal, and could only produce physical wreck. If they wished to assist those boys belonging to the poorer classes, whose parents could not afford to keep them at school or college until they were 16 or 17 years of age, the object of their teachers should be to give them as practical a knowledge as possible, and to eliminate as many mathematical difficulties as possible.

Prof. A. S. Wilson thought it would have been better if Dr. Nicolson had said that he was dealing with an ideal training and not with a training fit for the present day. The material that they had sent to them from the secondary schools was of very poor quality indeed. If they hoped, as they did hope, to have their secondary education put on a better basis, and got from them those that could write—they sometimes could not do that—they might be able to do something of the kind Dr. Nicolson had spoken of. They wanted colleges in centres so that the youth of one centre could be sent to the college to get a training. They had one in London, in the Central Technical College, and they might have one in Lancashire. At the present time it was difficult to get a well trained youth into works at all. Employers said we don't want these men in our works, we want workmen. As for the idea of students going for two years into works after they have left secondary schools and then leaving them again to go into technical colleges, the British employer of labour did not give much help in that direction. At present it was impossible to get a youth in for a short time.

Mr. C. H. Wordingham thought that Dr. Nicolson had spoken of the training of electrical engineers, not of technical workmen. If a man were to make it a profession he must enter it by the proper course of study and by devoting a certain portion of his time to the work. He thought it was only a very exceptional man who derived benefit from evening classes. As regards the ideal course of Dr. Nicolson, he thought the course admirable, but he did not agree with the order in which it was to be taken. In his judgment, it was best for a boy to go straight from school to college, and then enter the workshop.

Dr. C. H. Lees said that the early training of the youths they got was so deficient that they were not likely to attain Dr. Nicolson's ideal for some time. Those who came to be technical engineers should come direct from school to works.

Mr. W. H. Gee thought the most important suggestion of the paper was in the last paragraph. One firm in that district had made a start in the direction suggested, and he was able to say that the experiment was likely to be very successful.

Mr. Guy agreed with Mr. Wordingham, that to make an electrical engineer meant a great cost—several hundred pounds—if he were to know all that was wanted for public works and by public bodies. The higher training was very desirable, but he thought there were

very few who could follow out the course sketched out by Dr. Nicolson.

After a few further remarks by Mr. Rhodes,

The Chairman said he looked at the matter from the point of view of an employer, and was entirely in disagreement with Dr. Nicolson, and in agreement with Mr. Wilson. To have to break a boy from school at the age of 16, when he was learning how to learn, was a most serious matter. If he were going on to the University, it was a bad thing to have to break away from school life or college life. He was rather astonished when going through the works of the General Electrical Company to see some young men who looked very smart, and were hard at work. He was told they were the University chaps. They had come when they had attained the ages of 21, 22 or 23. It was very bad indeed for a boy to work during the day and then to work hard in the class at night. At 16 or 17 boys wanted a certain amount of football or something of that kind.

A letter from Mr. S. Joyce was read, after which Dr. Nicolson replied. The cordial thanks of the meeting were then tendered to him for his paper and the proceedings came to an end.

PHYSICAL SOCIETY.

Ordinary Meeting held February 22nd.

Prof. S. P. Thompson, President, in the Chair.

A paper on "How Air subjected to X Rays loses its Discharging Property and how it Discharges Electricity," by Prof. Emilio Villari (Hon. Fellow), was read by the Chairman.

Air made active by X rays in passing through a long tube coiled in many turns loses much more of its discharging power than it does in passing through the same tube if straight. During this process the tube charges itself to a certain potential. If active air is allowed to stream on masses of wire gauze or wound up ribbons, enclosed in tubes, the metals, independent of their nature, take a positive or negative charge according to whether the active air rubs against them with force or lightly. Experiments have been performed to prove this. For instance, tubes of copper or lead, if short and straight, take negative charges, but if long and coiled, they take positive charges. These phenomena cannot be attributed to chemical actions, but seem to be produced by a special rubbing of the active air upon metallic surfaces, as the result of which they assume one of the charges, and the other charge ought to manifest itself in the air. This is not the case, the charge of the air being often of the same kind as that of the metals. It has previously been shown by the author that active air by streaming against an electrified body is reduced either to ordinary air or to air charged with the electricity which disappears. Hence it may be supposed that the active air in rubbing upon the metallic surfaces develops the two electricities, one of which manifests itself upon these surfaces, and the other goes to reduce the active air to ordinary air and therefore does not become manifest. The electroscope used in the experiments consisted of a fixed brass plate and a gold leaf whose position was determined by means of a telescope with an eye-piece scale.

The Chairman said he had observed the fact that metals were charged sometimes positively and sometimes negatively by active air.

Mr. Watson asked if any experiments had been performed on the viscosity of gases rendered active by X rays.

The Society adjourned until March 8th.

INSTITUTION OF ELECTRICAL ENGINEERS (GLASGOW SECTION).

A METHOD OF COMPENSATING VOLTMETERS FOR THE VOLTAGE DROP IN LONG FEEDERS.

By Michael B. Field, A.M.I.C.E.

Paper read February 13th, 1901.

A problem which often confronts the central station engineer is the measurement at the power house itself of the voltage obtaining at distant parts of his network which supplies current for, say, lighting and power purposes. In fact, it is very often of far greater importance that the engineer in charge should know accurately the value of the voltage existing at the distributing network, or, better, the lamp terminals or motor terminals, as the case may be, than that obtaining at the central station bus bars themselves. In cases where the distributing network lies at some considerable distance from the power-house, and is fed with current by means of "feeders," the drop of voltage in the latter may vary from zero, when the network is very lightly loaded, to 10 or 12 per cent. when the network is heavily loaded. Under such circumstances the engineer requires, of course, so to regulate his generators that the voltage at the network or lamp or motor terminals remains constant; in other words, he must raise the bus bar voltage in the power house above the normal by an amount equal to the drop in the feeders.

In such cases a very usual course to adopt is to mount on the switchboard in the central station voltmeters which are connected to points of the network by means of "pilot" wires, and thus indicate the true voltage existing at those points. The engineer in charge can then readily regulate his generators so that, under varying conditions of load, the voltage indicated by these voltmeters is maintained constant.

In the year 1882 Dr. Hopkinson patented an arrangement for effecting the same purpose without resorting to the employment of pilot wires. His method consisted of compounding the shunt windings of electro-magnetic voltmeters with a few turns of thick wire, through which the main feeder current, or a proportionate part thereof, flowed. In this way a voltmeter connected to the near end of a pair of feeders might be compensated for the drop along the feeders and would thus indicate the voltage existing at the far ends, and obviate the necessity of employing pilot wires.

There is, of course, no great disadvantage in employing pilot wires for the purpose named beyond the cost of the same, which will amount to at least £90 per mile per twin wire. If it be possible to save this sum, which, especially in the case of long-distance transmissions or networks covering extensive areas, will amount to a very considerable sum, by merely adding a suitable arrangement of resistances at the switchboards, it will of course be advantageous to do so. Moreover, by obviating the pilot wire, we obviate the trouble often connected therewith; and while speaking on this point I would call attention to the fact that it is by no means uncommon for pilot wires to give trouble. What the reason usually is I do not know. Whether it is that while laying them they are considered as an adjunct of no vital importance, and therefore the necessary care is not devoted to their instalment, or whether it be for other reasons, is not a matter for discussion here.

Compounding coils of the above description are of course quite inapplicable to voltmeters constructed on the d'Arsonval principle, *e.g.*, Weston voltmeters, and in consequence of the almost universal preference shown by central station engineers for instruments of this class for continuous-current work, the writer some little while ago devised a method whereby any voltmeter whatever may be compensated for the feeder drop of either a two, three, or multiple wire system without necessitating constructional modifications of any kind, and, beyond that, can be arranged to indicate the *average* voltage obtaining at *any group* of distant feeding-points.

The method is capable of very general application, but three instances of its use are of special interest to central station engineers, and it is the object of this short paper, firstly, to describe briefly these three applications, and, secondly, to investigate analytically the accuracy of the same. The three cases for consideration are:—

(*a*) The measurement on the same instrument not only of the actual voltage existing at various feeding points of a two-wire network, but also the *average* of the voltage at all the feeding-points, or the average voltage at any desired group of feeding points of the network.

(*b*) The measurement of the individual feeding-point voltages and the average voltage at any group of feeding-points of a network on the three, five, or other multiple wire systems.

(*c*) The measurement by means of a low tension electrostatic multicellular voltmeter of the voltage at the far end of a long single or multiphase power transmission line working at extra high tension, and possibly possessing a comparatively large self-induction.

Let us imagine a large distributing network supplying current for lighting and power purposes over a considerable area. It is evident that a voltmeter in the power house so arranged that it indicated directly the average of the voltage all over the network would provide the engineer in charge with much more valuable information than one arranged only to indicate the actual voltage at some particular point of the network, for it is clear that the engineer should strive to maintain the average voltage at the normal value. Now, although it is not easy to obtain the true average of all points of the network, this may be approximated to by measuring the average voltage existing at all the feeding points; this information would as a rule be a sufficient guide to enable the central station engineer to maintain the average voltage over the network itself at its normal value.

It might further be advantageous for the engineer to be able to measure the average voltage existing at some one group or other of feeding-points, *e.g.*, during one portion of the day he might perhaps wish to pay most attention to keeping the average voltage throughout the commercial portion of the town constant, and at another time it would be of more importance to maintain the average voltage throughout the residential portion of the town constant. He might further wish to know at any instant what was the actual voltage at the end of some one long feeder supplying an outlying district, more especially if this feeder contained a booster so that the voltage was capable of independent regulation; all of these conditions become possible by the method about to be described.

Case A.—The additional switchboard apparatus necessary for this case—for, say, a continuous-current system—consists of a low-reading Weston voltmeter with a suitably graduated scale (*e.g.*, an ordinary 600-volt Weston with the series resistance removed would serve perfectly), a multiple contact voltmeter switch, a set of voltmeter resistances which would be mounted in an out-of-the-way place at the back of the switchboard, and, further, a series resistance for insertion in each feeder circuit. These latter resistances would be similar to those usually supplied with Weston ammeters, and would be such that the drop across them with the maximum current would be of the order of $\frac{1}{10}$th volt, or less where exceptionally heavy feeder currents are dealt with.

The multiple contact switch would be arranged for as many "positions" as groups of feeding points required. Suppose, for example, three feeding circuits A, B, C left the station, a four-way voltmeter switch might be advantageously employed. With the switch successively in the first three positions the voltmeter would indicate the feeding-point voltage of the network at A_1, B_1, C_1,

respectively, while with the switch in the fourth position the voltmeter would indicate the average voltage at the feeding-points A_1, B_1, C_1.

Two distinct arrangements are shown in figs. 1 and 2. Fig. 1 shows the simpler of the two, but involves the disadvantage that the

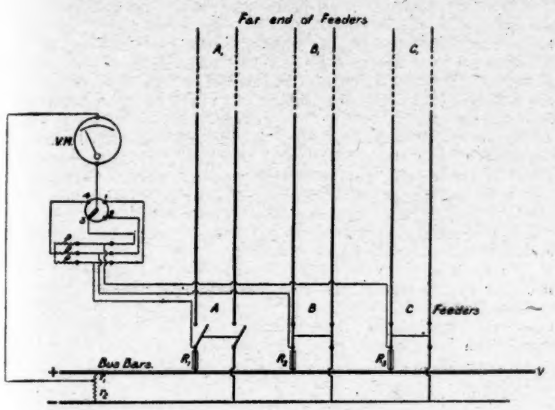


Fig. 1.

average voltage of A_1, B_1, C_1 can only be obtained if all three feeding circuits are switched in. It is, moreover, only possible to determine the individual values A_1, B_1, and C_1, if the corresponding feeders be switched in.

In fig. 2, on the other hand, a modification is shown whereby the individual voltages A_1, B_1, C_1, and the average of A_1, B_1, C_1, are given

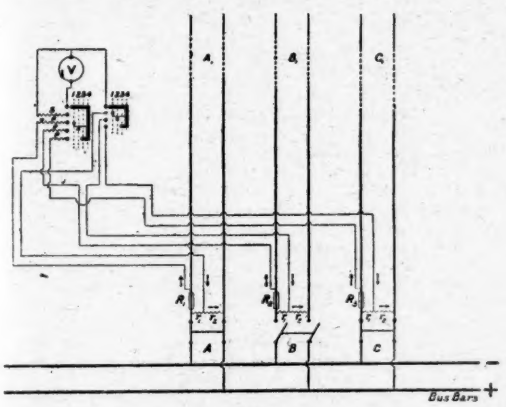


Fig. 2.

correctly by the voltmeter with the switch in the corresponding positions, whether some of the feeder circuits be switched in or not.

This involves extra complication in the multiple contact switch, in which case it may conveniently be constructed on the same lines as a miniature tramcar controller. In fig. 2 the contact cylinder has, for the sake of clearness, been developed on a plane.

R_1, R_2, R_3 are the inserted series resistances in the feeder circuits; shunt resistances (divided into r_1 and r_2) are connected in fig. 2 across each pair of feeders, in fig. 1 across the bus bars. The letter ρ represents that the particular connecting wires so distinguished must have sufficient resistance to prevent any appreciable interchange of current between the various feeder circuits when the switch is in the fourth position. V M is the voltmeter, and s a shunt which is connected across the terminals of the voltmeter when the switch is in the fourth position, in order to keep the calibration of the voltmeter correct.

Briefly explained, the principle involved is as follows:—

If r_1 be $\left(\frac{1}{n}\right)$th part of $r_1 + r_2$, the drop of pressure down r_1 will be $\left(\frac{1}{n}\right)$th part of the bus bar volts. Again, if R_1 be $\left(\frac{1}{n-1}\right)$th part of the whole feeder (go and return) resistance, the drop along R_1 will be $\left(\frac{1}{n}\right)$th of the total drop. The voltmeter, then, if connected to one feeder measures $\left(\frac{1}{n}\right)$th part of the bus bar voltage less $\left(\frac{1}{n}\right)$th part of the drop, *i.e.*, $\left(\frac{1}{n}\right)$th part of the voltage existing at the far end of the feeder. If a number of feeders be simultaneously connected to the same voltmeter, this latter will indicate the average of all the individual voltages. The connecting wires must, however, as already stated, have sufficient resistance (ρ) to avoid any appreciable interchange of current between the different feeder circuits.

The action of the shunt s, which is necessary with the arrangement shown in fig. 2, but not with that shown in fig. 1, will be found fully explained in the analytical treatment of the subject.

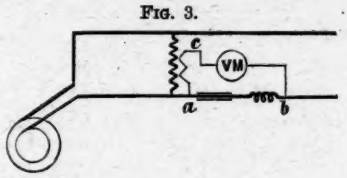
It may here be mentioned that the writer, on subsequent investigation, found that particular cases of his method had been anticipated by Mershon in America, and by Crompton and Ashley, and later by Heap, in England.*

Mershon's patents relate exclusively to alternating currents, since he bases them fundamentally on the use of either current or potential transformers, or both. Fig. 3 shows one of Mershon's arrangements, though many equivalent arrangements are illustrated in his patent specifications.

Mershon's object is to compensate the voltmeter not only for the ohmic but also for the inductive drop of the line, and his arrangement is only used in connection with single lines; *i.e.*, it corresponds to case (*a*), where the number of feeder circuits is unity.

As is evident from fig. 3, the shunt resistance $r_1 + r_2$ of fig. 1, is

Fig. 3.



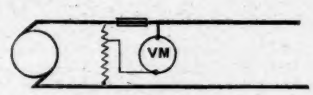


Fig. 4.

replaced by a potential transformer whose ratio is $n:1$. Further a resistance and a self-induction are inserted in the line whose values are $\left(\frac{1}{n-1}\right)$th times those of the line resistance and self-induction respectively.

Referring to fig. 3, we see then that the drop from a to b will be $\left(\frac{1}{n}\right)$th of the whole drop and in phase with it, whereas the secondary voltage of the transformer is $\left(\frac{1}{n}\right)$th of the generator voltage, and if the terminals be correctly chosen in phase with it. Thus the voltage $b\,c$, or that measured by the instrument, is $\left(\frac{1}{n}\right)$th of that existing at the end of the line.

The anticipations of Crompton and Ashley, and later by Heap, are merely case (*a*), where the number of feeder circuits is unity, *i.e.*, they compensate the voltmeter for the drop of voltage in a single pair of feeders by using shunt and series resistances as explained. The diagram of connections for this simple case is shown in fig. 4, and needs no further comments.

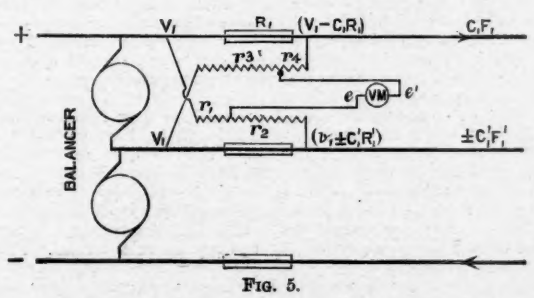


Fig. 5.

Neither Mershon, Crompton and Ashley, nor Heap, however, give any method for obtaining the average voltage at any desired group of feeding points, nor with one exception referred to later on, is any method given in the above-mentioned patents applicable to case (*b*), *i.e.*, when unequal currents exist in the go and return feeders as in the case of three-wire systems and the like. This case, however, is just as important as the foregoing, owing to the extensive use now made of the three-wire system.

In such cases the voltage at the network between the neutral and each outer may be required to be known. The switchboard apparatus needed is very similar to that already described, the difference being that in this case series resistances must be inserted in *each* main, and the potential resistances are somewhat differently

* Mershon: American Patent 551,982; dated December 24th, 1895.
" " " 571,839; " November 24th, 1896.
Crompton and Ashley ... 6,695; " ... ... 1898.
Heap ... ... 8,348; " ... ... 1898.

arranged. Fig. 5 shows the arrangement as applied to but one set of feeders. The voltmeter v will then be compensated for the combined drop both in the outer and neutral mains with which it is connected. If the average voltage between, say, the positive outer and the neutral at several feeding points be required, the arrangement of multiple contact switch as in fig. 2 may be employed.

The principle involved in this case is somewhat different to that of case (*a*), and may be best understood by comparison with a Wheatstone's bridge.

(*To be continued.*)

INSTITUTION OF ELECTRICAL ENGINEERS.

THE ELECTRICAL POWER BILLS OF 1900: BEFORE AND AFTER.

By Wm. L. Madgen, Member.

(*Abstract of paper read February 21st*, 1901.)

The intention is to consider those conditions of our electrical industry which led up to the Electrical Power Bills of the past session, to describe briefly some of the main features of the Bills themselves, and to urge the Institution to determine what its attitude should be in face of the charges of backwardness continually being made in regard to the applications of electrical energy in this country.

After the events of the past year there is little need to urge that the national sentiment is as sound among members of this Institution as in any part of the community, and the conclusion which has been forced upon us from all sides that the extent of our department of industrial work is far behind that of nearly every other important nation in the world is sufficiently mortifying.

We shall have to take our own part, or we shall find the public ordering German plant with the same complacency as they purchase German pianos.

It has become the custom with some of us to devote occasionally a few weeks to the visiting of other countries to benefit by the experience gained there in the developments of electrical work, and thanks principally to the energy of our secretary, this practice has become organised, and a largely increasing number now have opportunities of taking part in these expeditions.

The reflections ensuing upon these visits have no doubt varied in depth and in character with the individual and the nature of his occupations.

One of our greatest science teachers, in his presidential address, which lives in our memory, referred in inspiring terms to the visit to Switzerland, and the revelation it was to us. We were, he said, very much like what engineers of 1870 would have been if brought suddenly into a generating station, and attributed much, if not most, of our backwardness to our knowing too little theory.

I am inclined to the view that this lack of theoretical knowledge is an effect rather than a cause of our troubles. In Germany and Switzerland, particularly, we see a systematic devotion to technical and scientific training, but the Americans have applied themselves rather less to the principles than to the applications of science, and it is the latter country which is probably the most in advance of us in electrical engineering.

It is unnecessary, however, to give occasion for a discussion on theory *versus* practice. I am sure we take it to heart that we have too little theory, and will loyally support those who are endeavouring to apply more scientific methods to our manufactures. I am more apprehensive just now concerning the scope for the employment of the young electrical engineer when he has been prepared by the most approved methods.

We have no feeling but cordial goodwill for those friends abroad who have made our visits so pleasant and instructive; but the reflections of many of us on our return have been those of indignation at the obstacles set in the path of our industry by the governing bodies of this country, and of resentment at the wretched waste of energy and enterprise which they have occasioned.

The electrical engineers of the United Kingdom are not to blame, and there is no occasion for any apology on their behalf. I am aware there may be those who are interested in the maintenance of old methods of working, and we have internal complaints now and again for which the Observatory at Kew may for the moment be taken as a symbol. But we can put such issues past us for the present, and consider whether it is not our duty to make a united effort to secure liberal measures of enfranchisement.

The position cannot be attributed to lack of ability or inventiveness on the part of British engineers. Some of the most important improvements have been worked out in this country, but our environment has been too much for them, and they have found their fullest practical application abroad.

What is the reason, then, that our electrical industry is behind that of nearly every important country in the world?

It is due, in the first place, to silly legislation by Parliament and to obstruction by the numerous local authorities entrusted with arbitrary powers. In the second place, it is due to a class of quasi-officials and their associates to whose direct monetary advantage it is that an opposition should be entered to every project in which they are not employed.

There may be contributory causes, but to these, and others that flow from them, our chief difficulties may be assigned.

Ere this Institution was founded an obstacle had been prepared for us. In 1870 was passed the Tramways Act, and these are some of its leading provisions: A tramway cannot be authorised by provisional order without the consent of the local authority of the district. If the proposed tramway is to run through two or more districts, and consents have been obtained in respect of two-thirds of the length, the Board of Trade may, upon inquiry, dispense with the consents for the remainder.

When the procedure is by provisional order, the construction of the line can be absolutely blocked by notice given in the prescribed manner by one-third of the owners, or of the occupiers, of the premises abutting upon the road where for so short a distance as 30 feet or upwards there would be less than 9 feet 6 inches between the outside of the footpath on either side of the road and the nearest rail of the tramway.

The most onerous condition is provided in the notorious Section 43, by virtue of which the local authority can purchase a tramway at the expiration of 21 years from the date of the order, or of any subsequent period of seven years, on the terms of paying the then value of the tramway, exclusive of any allowance for past or future profits of the undertaking, or any compensation for compulsory sale, or other consideration whatsoever.

We shall agree with Mr. Granville C. Cuningham, general manager of the Central London Railway, that "there is, perhaps, nothing that has done so much to prevent the relief of overcrowding and congestion as the Tramways Act of 1870. Its provisions in rigidly limiting the term of the concession to 21 years, and practically fixing the price at which the municipality may take over the undertaking at something far below its value, have effectually checked the growth of electric systems.

If procedure by special Act is resorted to, the Standing Orders of the two Houses require in like manner the consent of the local authority, so that the undertaking is not furthered in that respect, and is equally liable to be bled for the purpose. The frontagers are given a *locus* to oppose, so that a small number of them are not so well able, through caprice or other motive, to prevent the construction of an important line; but the expense and risk of procedure by special Act have been sufficiently serious deterrents.

I think the net result will justify us in agreeing with Mr. Balfour Browne that this same Tramways Act was "a very silly contrivance indeed."

Consider the waste of energy and of enterprise in battling against such conditions, and whether it is any wonder our countrymen have to complain that we are lamentably behind the rest of the world in the cheap and rapid transport facilities afforded by electric traction.

We have* pleaded that there is no country in the world which would benefit more than our own by the provision of comprehensive electric tramway systems, or that stands more in need of them to relieve overcrowding, yet their introduction has been slow and halting, and carried out in the face of bitter opposition. Instead of lending a helping hand, governing bodies seem to have thought they were doing the public a service by narrowing enterprise down to the scantiest possible outlets, and in some cases by establishing an effective blockade against it.

Twenty-six years elapsed—near upon a generation—and it was not until 1895 that the repose of the Board of Trade was disturbed—a body curiously constituted and still more curiously named—and it was found that something really must be done. A Commission was then appointed to consider the question of tramways and light railways, and as a result of their report the Light Railways Act was passed in 1896, only four years ago. But this was only a tentative provision, it expires this year, and unless some measure of enfranchisement is passed, we shall be thrown back upon the Act of 1870, which remains effective upon the Statute Book.

The other great department of our domain, the general supply of electrical energy for industrial and domestic purposes, is even yet almost entirely governed by the Act of 1882, which was passed at a time when "the state of the art" was such that electrical energy could only be supplied economically for a distance of a mile to a mile and a half from the generating station.

In effect the legislation was made to match the fact that at least one separate station was then required for each town, and the Town Council was constituted the authority which could either undertake the work itself, or consent to the acquirement of the necessary powers by a company.

In either case the Act contemplated the local authority being the ultimate owner of the local undertaking. The clauses as to consent, the period and the terms of purchase, were inspired by the spirit of the Tramways Act of 1870, and the effect upon electrical engineering as a national industry has been equally disastrous. The result was a *fiasco*. What did Parliament then do? Nothing until 1888, when it climbed down in a half-hearted way—analogous to its performance in connection with the Light Railways Act—and passed another measure extending the purchase period from 21 to 42 years, but leaving the onerous consent clause and the ridiculous terms of purchase as they were.

Until after the Act of 1888 we could do practically nothing in the way of establishing electrical supply undertakings.

Circumstances were more favourable in America and Germany during those six valuable years, and, encouraged by the home demand, which is an essential condition of enterprise abroad, the manufacturing trades of those countries laid the foundations of their great export business in electrical plant and accessories, the consequences of which we are feeling to-day.

America and Germany now hold the great bulk of the export trade of this character, not only to the countries of Europe, and to

* See particularly paper by Mr. Granville C. Cuningham in the *Tramway and Railway World*, December, 1889.

South America where this country has heavy financial interests, but also to our own Colonies and the United Kingdom itself.

You will remember that the whole of the steam engines, dynamos, electric lifts, &c., for the Central London Railway, were supplied from America, and many other examples will occur to you.

As I have said, the legislation was in effect made to match the fact that in 1882 it was necessary to put down at least one generating station for each town, and the conception of the situation by many local authorities is shown by their persistent endeavours to wall themselves in, so to speak, against the improvements by means of which the area of economic supply has vastly outgrown such limits.

The Acts of 1882-88 and their administration have proved entirely congenial to the narrow exclusiveness of these bodies, who are endeavouring even now in their opposition to the Power Bills, to ensure themselves against the developments of science and a cheap supply rather than impair the prospect of their being able to have an isolated municipal plant all to themselves some day or other.

The statistics available afford us the following figures:—

—	Electricity works in operation.		Undertakings for which orders have been obtained, but works not yet carried out.	
	Local authority.	Company.	Local authority.	Company.
1901 ...	130	68	212	55

Of the 55 undertakings which have not yet been carried out by companies, only three of the provisional orders (not taken by transfer from the local authority) are two years old yet, and 32 of the remainder only date from last session. Many of the works are now in course of construction, and very few are being hung up in any way that I am aware of.

Of the 212 orders not yet carried out by local authorities, the works in 89 cases are, I believe, in course of construction or have been more or less decided upon, leaving a balance undecided of no less than 123.

Under a provisional order, the time within which a supply should be available is two years from the date of the order, but of the 212 towns referred to a large proportion have exceeded that period, some of the dates tailing back so far as 1891, 1892 and 1893.

The figures do not really show the full extent to which business is retarded, because no one has tabulated the local authorities who not only have not applied for a provisional order, but of whom it is known that they would have blocked any application; but the state of affairs is sufficiently shown by the fact that throughout the whole of the United Kingdom electricity supply under the Acts is only available to the public in some 250 districts.

Now we know that the consumer can procure his electrical energy on a more favourable basis for all concerned from an undertaking dealing with a comprehensive area and varied classes of demand, than he can get it from a relatively small local station. This being the case, it may be supposed that it could only be a question of time when the obstacles, obstinate though they have been, to the cheap supply and to a large extension of the industry must give way somewhere.

The first break in the clouds was observed in 1898, when a Joint Select Committee of the two Houses was appointed (at the instance of the Lords) to consider and report upon a reference in regard to "Electrical Energy—Generating Stations and Supply."

Time does not serve to detail the circumstances which led up to the appointment of this Committee, to describe the Bills then pending in Parliament in which it was proposed to give effect to the developments of electrical science, nor can I read you the full terms of the reference or of the report,* but I extract the following paragraphs from the latter:—

"Where sufficient public advantage is shown, powers may be given for the supply of electrical energy over an area including districts of numerous local authorities, and involving plant of exceptional dimensions and high voltage. The Committee further think that undertakings of this character may properly be authorised on conditions differing in some respects from those imposed by and under the existing Acts.

"The Committee consider that the provisions of the Electric Lighting Act, 1888, which require the consent of the local authority as a condition precedent to the granting of a provisional order, should be amended. In their opinion the local authority should be entitled to be heard before the Board of Trade, but should not have, so to speak, a provisional veto, only to be dispensed with in special cases by the Board of Trade."

It was the feeling of electrical engineers that the report was too moderate considering the attitude maintained by the local authorities and their notorious misuse of the powers conferred upon them by the Acts, but this feeling is turning to one of dismay at finding that during the two or three years which have ensued nothing whatever has been done to carry out the recommendation last mentioned—which is a full justification of much that I have urged—and that their exertions continue to be very largely wasted.

It might be gathered from the continued lamentations of the Press that the electrical engineers of this country were likely to be put upon their defence, and this might indeed be a consistent involution of the legislation which has already tried us very severely in another sense, but it cannot be said that we have been slow to act upon any measure of encouragement available to us. This was true of the Act of 1888, so far as its provisions would allow, and there has been absolutely no hesitation or delay in turning to practical account the paragraph in the report from which I have just read, with reference to the supply of electrical energy over extensive areas by means of plant of exceptional dimensions and high voltage. I have referred to the Bills pending in Parliament at the time of the report, and we must acknowledge the valuable pioneer work of some of our members in connection with them.

The Bill which affected our prospects most strongly, although it did not pass, was promoted by the General Power Distributing Company in 1898-99, and was familiarly known as the Warsop scheme, the project being to distribute electrical energy over an area comprised within a radius of 26 miles from Warsop, in Nottinghamshire. The district includes such populous centres as Sheffield, Rotherham, Nottingham, Lincoln, Doncaster, Derby and Chesterfield. The powers sought were to lay trunk mains throughout the area, to give a supply of electrical energy, except where the local authority was itself empowered to supply under an order or Act and agreed to take a supply in bulk from the company on arbitration terms. To supply direct in all cases to consumers taking 10,000 units per annum and upwards. The conditions in regard to district, &c., were favourable, and large quantities of coal slack were available at 2s. per ton in the neighbourhood of the proposed power station. The Bill, as we know, did not then pass, but the powers which it sought to obtain have a considerable interest from the point of view of to-day, as in varying degrees they are reflected in the four Power Bills which were passed last session.

Before summarising the considerations relating to the supply of electrical energy over extensive areas it will be convenient to follow the course of events. Public opinion became gradually informed on the subject, and it is to be hoped a little moved at the sense of national backwardness, and in the session of 1900 four Electric Power Bills, each for supply over important English areas, passed through Parliament. These were:—

The County of Durham Electric Power Supply.—This area, about 250 square miles in extent, comprises the main portion of the Durham coalfields and one of the leading manufacturing and shipbuilding districts of the North-East coast. Provisional orders had been obtained authorising the retail supply to consumers in the chief towns, viz., Gateshead, Jarrow and Durham City. The British Electric Traction Company had undertaken an extensive system of electric tramways in Gateshead and district, and have since obtained powers for lines in the Jarrow and Durham City districts. The Power Act authorises the laying of trunk mains throughout the area, and the supply of electrical energy in bulk to undertakers authorised to supply, and also to undertakers authorised to use it for prescribed purposes.

Thus the supply may be given at once for general use in Gateshead, Jarrow and Durham City, and for electric tramways and light railways in Gateshead, Jarrow and other parts of the county.

The first portion of the main power station on the river Tyne at Gateshead is rapidly approaching completion, and will be available this spring for a comprehensive system of supply which is being prepared in readiness for it.

The North Metropolitan Electric Power Supply.—This area, about 325 square miles, includes the great suburbs to the North of London, from Tottenham on the east to Harrow on the west, and the growing manufacturing districts along the river Lea. It covers the area within which the extensive North Metropolitan electric light railway has been carried through by interests friendly to those of the Act. The provisions and general considerations are the same as in the County of Durham Bill, and the same general policy was followed.

The Lancashire Electric Power.—This Act takes in the whole of Lancashire south of the River Ribble (except Manchester, Salford, Bootle, and Stockport), an area of about 1,000 square miles. The district may appear somewhat large, but a great part of it is undoubtedly very suitable, since it comprises a large number of collieries, engineering works, cotton mills, and a variety of other industries. The Act contains powers to lay trunk mains throughout the area, and to furnish electrical energy in bulk to undertakers authorised to supply, the promoters having relied upon the cheapness of production at large generating stations as sufficient to secure holders of electric lighting provisional orders as customers for bulk supply.

The South Wales Electric Power Distribution.—This includes the whole of the County of Glamorgan, and extends into Monmouth as far as the River Usk (also including Newport), an area of about 1,050 square miles. The principal towns are Cardiff, Swansea, Newport, Barry, Merthyr, Pontypridd, and Neath, and the district thus comprises the great colliery, shipping, and manufacturing districts of South Wales. The provisions of this Act are similar to those of the Lancashire Act, with one important difference. The South Wales company were given powers to supply direct to *any* person for power purposes, and for lighting any premises on some part of which the power is utilised, provided only that in a local area where an electric lighting provisional order exists, the consent of the authorised distributor in such area is first obtained. If such consent is withheld, the Board of Trade may dispense with it if, in the opinion of that body, the authorised distributor under the provisional order is not willing and in a position to give the requisite

* In the House of Commons, July, 1898, Mr. Ritchie, replying to Mr. Kimber, said that the report of the Joint Committee would be carefully considered by the Board of Trade, but legislation would be required to give effect to some of the Committee's recommendations, and he was afraid that the prospect of passing a Bill through that session was very small. The prospect must have been small indeed, for the process of official consideration has extended not only over 1898, but also beyond 1899 and 1900.

supply to the power user upon reasonable terms and within a reasonable time.

All these Acts contain a sliding scale clause as regards prices and dividends, also powers for the revision of the scale every ten years by the Board of Trade, 8 per cent. being taken as the normal maximum dividend. The general clauses follow pretty closely the usual electric supply practice; for details reference should be made to the Acts themselves.

There are a few examples of groups of provisional orders having been obtained for adjoining districts by arduous negotiations extending over several sessions. These undertakings typify many of the difficulties with which electrical engineers have had to contend, but they are not more fully referred to here, as the form of procedure was not by Power Bill. There is, however, an important Northumbrian undertaking dealing with the north bank of the Tyne from Newcastle to North Shields (excluding the latter) with part of the hinterland, which belongs to both classes, and should not be omitted from the list, especially as it has been one of the first to get to work.

The main purpose of the Power Acts is to keep the number of power stations within economical limits, and by the selection of suitable sites and the equipment of works of considerable magnitude to enable electrical energy to be transmitted in such a manner that the retail price to the consumer will be reduced to a figure which will compare with, and in many cases be far lower than, that of any other form of power, whether gas, steam, oil, or other agent.

The enormous development of electricity in the United States and Canada and on the Continent of Europe, and the numerous great electrical power distributions over large areas in those countries, are in themselves practical evidence in favour of the principles we are advocating. It cannot be urged that the requirements of this country, so far as trade and cheap production are concerned, are different to those obtaining in the countries mentioned.

The absence of undertakings of the kind in the United Kingdom has not been on account of any difficulty or impossibility on the engineering side, or from the lack of suitable conditions. We have few large water-powers, it is true, but there is an equally good source of power available, and coal in this country can replace, on favourable terms, the water-power available elsewhere for the generation of electrical energy. Moreover, even in those parts of the country where coal is more expensive than in the coal districts themselves, relatively cheap electricity may be available if it is generated in sufficient quantity at large power stations, and the supply from such stations is distributed over a suitable area. Capital charges, management, rent, rates, and taxes usually form a larger proportion of power-station costs than fuel, but the greater the importance we have to attach to the fuel item, the more necessary it is to adopt the most comprehensive methods, and to concentrate and economise its use.

Under the Electric Lighting Acts, and the conditions heretofore existing, the scarcity of the electricity supply in this country has been due to the high cost of production. Even in the more developed areas the cost has been too high as a general rule to admit of its being freely used by the consumer on terms more advantageous than those upon which he can employ steam or gas for industrial purposes, or gas or oil for domestic service.

Statistics have shown us that the average cost of production and supply to consumers becomes lower as the output of the power station increases, but the difference between stations supplying 1 million and 4 million units per annum is less, and not in proportion to that obtaining between smaller stations with much less difference of output. Without an increasing "diversity factor," this difference would tend to disappear as stations increased in size.

A good "diversity factor" can only be achieved by combining with electric lighting the supply of energy for as many and as various other purposes as possible, and, so far as lighting is concerned, the supply to every class of consumer. As the area of supply is extended, the "diversity factor" tends to improve, owing to the difference in the incidence of the demand in different districts.

(*To be concluded.*)

ELECTRIC AUTOMOBILES AT CHISLEHURST.

Judges' Report.

The trials of vehicles propelled by electricity were made under the auspices of the Automobile Club of Great Britain and Ireland, at Chislehurst, in November of last year, and were fully reported in the Electrical Review of November 16th. These trials were the first of a public or official character made of electrically-propelled vehicles in this country, and their importance may be gauged by the list of judges, who consented to make the tests, and report upon the results, viz.:—Prof. C. Vernon Boys, Prof. C. A. Carus-Wilson, Mr. Hugh E. Harrison, Major H. C. L. Holden, R.A., Sir W. H. Preece, K.C.B., Sir David Salomons, Bart., Mr. James Swinburne, and Mr. Alex. P. Trotter. Mr. Llewellyn Preece acted as honorary technical secretary to the Judges' Committee, and Mr. Claude Johnson, the secretary to the club, gave his personal services throughout the trials, and especially in the choice of routes and organisation, and control of the cars.

The report of the judges, after three months' consideration, is now before us. It is somewhat disappointing, and does not appear to be altogether commensurate with the expense incurred by the club, and by the competitors who submitted their vehicles to the tests. The cost of these trials to the competitors must have been very considerable; there was an entrance fee of £8 8s. for each vehicle, and in addition, the charges for current, wages of attendants and workmen in the preparation of the cars, and we know that several of the competitors went to an expense of some hundreds of pounds to bring vehicles from abroad, especially for these trials. The making of Chislehurst the headquarters, instead of carrying out the manufacturers' recommendation, viz., "The courses to commence and finish in London," added considerably to the expenses of the competitors, and together with the unnecessary precaution of not disclosing the courses and place of assembly to the competitors, until two days before the trials, contributed very much to the absence from the trials of several of the carriages previously entered. No. 4, a delivery car, withdrew at once, Nos. 2, 3, 5, 6, 7, and 10 withdrew on the first day, and had proper notice been given of the courses, some of them would probably not have entered at all.

The report states, "At the time at which the trials took place, large parts of the road were deep in mud, and the Judges' Committee desire to emphasise that not only were the roads hilly in nature, but the surfaces generally were in an extremely bad condition, and made travelling heavy." Now electrical carriage manufacturers have always contended that electric carriages are most suitable for use in towns, and it was an unusually severe trial to put carriages, made for town use, on to the rough, hilly roads, and then to compare them with petrol cars built specially for such use; in spite of these disadvantages we adhere to the opinion* "on the whole, under the more than ordinary difficulties, the four days' successive spins were made with an aggregate of about 600 miles for the five vehicles, or an average of about 30 miles per day for each vehicle, with hardly a mishap," and the results obtained "must be accepted as proving the practicability of electrical propulsion on common roads."

The preliminary regulations were very good, but, we gather from the remarks of the Judges' Committee, were not strictly adhered to, particularly as to the same batteries being used throughout the trials, and in the case of vehicle No. 12, the voltage was not even taken. The diagrams of the electrical connections were, as far as we can gather, not asked from or supplied by the competitors, and no information is given in the report as to the electric motors used, whether shunt or series, or as to the system of control, and grouping of the motors and batteries for varying speeds. No mention is made of the mechanical construction, make of tires, brakes, whether electrical or mechanical, steering facilities, or other details, or of the suitability of the design of carriages, and it would appear that these trials of electric vehicles were not made with the same zealous care and attention to detail that has characterised the trials of petrol and steam cars.

Of the 13 cars that entered, the results of five only are tabulated, the others from various causes being withdrawn. These five were:—

No. 1.—"The Powerful," a Kriéger car for two persons, with Leecoll batteries, type 30 EE, 60 cells, and Postal-Vinay motor.

No. 8.—National Motor Carriage Syndicate, Joel car, to carry two persons, with Rosenthal battery and Joel motor.

No. 11.—Electric Motive Company's car to seat four, with the company's batteries, and four-pole enclosed series motor.

No. 12.—Still Motor Company's car for four persons, with Ideal battery and Still Motor Company's motor.

* Electrical Review, November 23rd.

No. 13.—The Electrical Undertakings Company's car to seat three to four persons, with Leitner battery and Lundell motor.

The following table gives the results of the trials of these cars:—

Tables 2 and 3 serve to elucidate the trials, and it is most interesting to examine the drop in voltage in connection with each day's run. The ratio of weight of the battery to the total weight is of vital importance, as it is evident that the greater this ratio, the longer must be the run in miles per

Table 1.—Electric Car Trials. Chislehurst, November 6th, 1900.

No of car	1	3	4	5	8	10	11	12	13
No. of passengers carried	2	2	2	2	2	2	2	4	2
Weight of car including passengers	48·5 cwt.	Not taken.	Not taken.	Not taken.	19 cwt.	Not taken.	30¼ cwt.	18½ cwt.	26¼ cwt.
„ battery in lbs.	3,300	—	—	—	846	1,320	1,416	756	1,042
Ratio weight of battery to total weight	·6	*	*	*	·4	—	·414	·365	·3
Normal voltage	150	—	—	—	33	74	61·5	80	86
Tuesday's run, miles	59	—	—	—	36¾	17*	33	23	33½
Average speed, miles per hour	10·92	—	—	—	7·35	—	8·25	12	7·5
Open circuit volts, beginning	158	—	—	—	33	—	60	Not given.	86
„ „ „ end of run	128	—	—	—	30	—	45		71
Tuesday night's charge, units	63·4	—	—	—	20·9	—	26·9	11·6	16·5
Wednesday's run, miles	24¼	—	—	—	—	—	21¾	21¾	21¾
Average speed, miles per hour	12	—	—	—	—	—	8·8	11·25	8·5
„ „ up Knockholt do.	8·34	—	—	—	—	—	6·52	9·66	5·78
Open circuit volts, beginning	156	—	—	—	—	—	61·5	Not given.	Not given.
„ „ „ end of run	—	—	—	—	—	—	59·3		
Units per mile run, based on previous night's charge.	2·59	—	—	—	—	—	1·235	·533	·757
Wednesday night's charge, units	59·7	—	—	—	—	—	19·9	9·0	14·1
Thursday's run, miles	29¼	—	—	—	—	—	29¼	29¼	29¼
Average speed, miles per hour	12	—	—	—	—	—	8·3	8·68	7·63
Open circuit volts, beginning	158	—	—	—	—	—	60	Not given.	86
„ „ „ end of run	—	—	—	—	—	—	48		80
Units per mile, based on previous night's charge.	2·01	—	—	—	—	—	·682	·308	·482
Thursday night's charge, units	51·8	—	—	—	—	—	19·8	8·6	14·8
Friday's run, miles	60	—	—	—	—	—	14¾	17	35¾
Average speed, miles per hour	9·8	—	—	—	—	—	7·2	11·3	7·4
Open circuit volts, beginning	153	—	—	—	—	—	60	Not given.	86·5
„ „ „ end of run	100	—	—	—	—	—	55		54·5
Units per mile, based on previous night's charge.	·865	—	—	—	—	—	1·34	·505	·414
Total mileage for four runs	172·½	—	—	—	36¾†	—	98·¾	91	120½
Average speed, miles per hour	10·97	—	—	—	7·35	—	8·22	10·75	7·66
Best day's run, miles	60	—	—	—	36¾	—	33	29·25	35·75
Miles per cwt. of car	1·242	—	—	—	1·93	—	1·09	1·58	1·36

* Cars were withdrawn on the first day.

† No. 8 carriage ran 36¾ miles on Wednesday, the longest run on that day of any carriage; 16 miles on Thursday; and 8 miles on Friday—but owing to sand and road grit getting into one of the ball bearings, the balls were broken and the bearing jammed, causing the chain to come off. This carriage was run with one motor only the last three days, in order to qualify for the report.

The Judges' Committee give their conclusions as to the results of the trials, in the last line of Table 1, but we have analysed the figures given and placed the cars in their order of merit, as well as giving the drop in voltage and comparative weights in the following Table 2:—

cwt., and other things being equal, the more economical the cost of the car per ton-mile.

The charges given in Table 1., as taken by each battery each day, are not capable of correction; there were no suitable recording meters, and the current was intermittent, so

Table 2 ("Electrical Review").—Best Day's Run in Miles.

Order of merit.	No. and name of car.	Efficiency. Weight of car, including passengers.	Best day's run. Miles.	Miles per cwt. of car.	Percentage of efficiency.	Weights. Weight of battery.	Weight of vehicle.	Ratio weight of battery to total weight.	Battery. Drop in voltage, best day's run.	Per centage of drop at end of run.	Charging current asked for by makers.
											Ampere-hours.
1	No. 8, Joel car	19 cwt.	36¾	1·93	100	846 lbs.	1,182 lbs.	·44	33 to 30	10	200
2	No. 12, Still car	18½ „	29¼	1·58	81·8	756 „	1,216 „	·365	Not given.		200
3	No. 13, Electrical Undertaking Co.'s car.	26¼ „	35¾	1·36	70·5	1,042 „	1,926 „	·3	86—54·5	36	200
4	No. 1, Kriéger car	48½ „	60	1·242	64·3	3,300 „	2,032 „	·6	153—100	35	400
5	No. 11, Electric Motive Co.'s car.	30¼ „	33	1·09	56·5	1,416 „	1,972 „	·414	60—45	25	250

* See Electrical Review, November 16th, 1900.

This table shows the results obtained by each car with their best day's run on different days, but as the courses varied each day, it is obviously more correct to compare them all on the same day's run, that is, the first day's run, which was the severest trial of all, as the run was to be to a finish.

that we have given the makers' own requirements in our tables, as a better guide as to the current taken on each day.

A comparison of "miles per cwt. of car" is not so accurate as "watt-hours per ton-mile" would have been, for whereas the "miles per cwt. of car" results would have

Table 3 ("Electrical Review").—All Cars on Same Day, and Same Route.

Order of merit.	No. and name of car.	Efficiency.				Weights.			Battery.		
		Weight of car, including passengers.	All same day's run. Miles.	Miles per cwt. of car.	Per-centage of efficiency.	Weight of battery.	Weight of vehicle.	Ratio weight of battery to total weight.	Drop in voltage same day's run.	Percentage of drop at end of run.	Charging current asked for by makers.
1	No. 8, Joel car	19 cwt.	36¾	1·93	100	846 lbs.	1,182 lbs.	·44	33 to 30	10	200
2	No. 13, Electrical Under-taking Company's car.	26¼ „	33½	1·27	65·8	1,042 „	1,926 „	·3	86 „ 71	17·5	200
3	No. 12, Still car	18½ „	23	1·24	64·3	756 „	1,216 „	·365	Not given.		200
4	No. 1, Kriéger car ...	48½ „	59	1·21	62·7	3,300 „	2,032 „	·6	158 to 128	20	400
5	No. 11, Electric Motive Company's car.	30¼ „	33	1·09	56·5	1,416 „	1,972 „	·414	60 „ 45	25	250

appeared better as the weight of the car was reduced, the "watt-hours per ton-mile" takes both weight and speed into account, and the current readings are a much better guide to the power taken and the efficiency of the electric batteries, motors, and system of control.

The report would have been more valuable had the observers' notes as to the current taken during the run been used in conjunction with a test of the cells, which we understand Mr. L. Preece had in hand for the club, for as we pointed out in our article in the Electrical Review of November 23rd, the total watt-hours could have been calculated from this basis.

The remarks as to recuperation are unsatisfactory. Surely recuperation is an easily determined quantity, and if the conditions of the grouping of the batteries and circuits, whether with, or without resistances, are known, together with the total weight of the car, tractive resistance in pounds per ton (one of the points that should have been ascertained), and the gradient measured, then the calculation of the recuperative effect, given by driving the motor as a generator, whilst going down hill acting as a brake, and at the same time charging the battery, could be readily made, and checked by the actual observations of time, amperes, and volts. The remarks in the report that "The experience of the observers, however, was unanimously to the effect that this action really amounted to very little in practice. Considerable currents were, no doubt, returned, but for such short intervals of time that the saving in energy was practically nil," should not pass unchallenged, and we propose to show that recuperation is of very great advantage, while it is one that no other system of self-propelled car possesses.

Taking the observers' notes as to No. 8 car (published at the time of the trials), the highest current recorded for this car when ascending the steepest hill (Orpington, 1 in 10) was 119 amperes, and the lowest current taken in descending the same hill, was a back charge, or recuperation of 35 amperes. The total weight of the car, with passengers, was 19 cwt. The tractive resistance can be taken for the rough gravel and macadam roads as 50 lbs. per ton on the level, *i.e.*, 47·5 lbs. for this car, then the effective horse-power required to propel this car up 1 in 10 at a speed of 6 miles per hour, would be 4·3 effective H.P., and this corresponds to the actual current observed, viz. :— 30 to 32 volts, 119 amperes, the efficiency of the electric motors with connecting wires and contacts being taken at 84 per cent. The additional power in foot pounds required to ascend the gradient of 1 in 10, and included in the 4·3 effective H.P. given above, may be taken as $\frac{V \times W}{10}$ where V is the speed of the car in feet per minute, and W the total weight of the car in pounds, and it is evident that a considerable part of this power, less the tractive resistance, is available when descending a hill of 1 in 10, for recuperating or charging the battery. Allowing for 25 per cent. more speed when going down-hill for generating, and taking the efficiency again at 84 per cent., the actual power available is about 1·9 H.P., and this at 40 volts, will give 33 to 35 amperes as the current charging back to the battery, corresponding with the observers' notes. The duration of this charging is less, as the speed is increased 25 per cent., but taking that into account, in our example, and at the speeds given, there would result a return of about 23·5 per cent. of the energy taken when ascending the same hill, and this agrees with many observations taken on many runs. Of course the speed down-hill would be comparatively slow, only 7·5 miles per hour, but with a hill of say, 3 miles, the current returned would be from 10 to 20 ampere-hours, which would be sufficient to propel this car another 3 to 5 miles on good level roads, and such a gain might be most convenient at the end of a long day's run, and is surely not a negligible quantity. If the car were sent down hill at 15 miles an hour, it would still give a back charge to the battery, but for only half the time. A most direct advantage is found in this recuperation, viz :— in depolarising the batteries, and thus restoring them to their highest possible E.M.F., after the heavy discharge taken from them when ascending.

In the preliminary work of organising these trials, it is evident that much patient labour and care were given as to the conditions and details, but the practical knowledge of what was specially required for vehicles propelled by electricity appears to have been wanting. The absolute necessity of dry houses for storing the cars, proper facilities for charging and accurately determining the amount of charge given to the batteries, tests of the cars with self-recording meters, the tractive resistance of each car, and other such details and suggestions as are set out in the Electrical Review of November 23rd last, should be considered in future trials, and the practical views of manufacturers and owners should also be consulted at every stage of the trials. We hope that a report of the tests of the batteries made by Mr. Llewellyn Preece will be added to the present one.

THE ELECTRICAL TRADES UNION'S PROPOSED RULES.

Whether or no the officials of a Trades Union understand the first principles of the economic laws which govern capital and labour, whether or no they believe labour to be a constant quantity, or whether, which is more probable, they never give a second thought to such things, is a matter which does not trouble the individual contractor or employer of labour.

His chief concern is to know how a Trades Union will affect him personally in his dealings with his men, and whether its tendency is to make him the master or the servant. Experience has shown that the tendency of modern Trades Unionism is to reverse the recognised order of things, and to make the employer the servant of the employé.

Probably no industry has felt the curse of latter-day Unionism to the same extent as has the electric wiring trade. Just as an electrical engineer must know something of almost every other branch of applied science, so an electric wireman, worth his salt, must know a little of many other trades besides the simplest of them all, viz., the laying of wires in grooves or pipes.

Nowhere is the abuse of unionism more noticeable than in the electric lighting of a steamship. No sooner does the wireman—that is, the all-round wireman, who can do everything from the soldering of a joint to the cutting of a mitre—commence operations on board ship than his

troubles begin. If he handles a saw or a wood chisel, the joiners' delegate — there is generally a delegate handy — gently reminds him that *that* is joiners' work. If the reminder is not sufficient, the wireman is informed that unless he ceases doing joiners' work, all the shipyard joiners will go out on strike. There is nothing for it then but to employ a joiner. He must now be very careful not to instruct his joiner to cut a hole in a wooden bulkhead or in a deck which is above a certain specified thickness, or the carpenters' delegate will promptly inform him that none but a trades union carpenter is permitted to do such work.

A strike of ships' carpenters once occurred on an installation, because the joiners employed on the electric work were instructed to cut a groove in a cargo batten to receive a cable. In the end the carpenters had to do this, and also to screw on the capping.

If the wireman attempts to wipe a lead-covered joint, or to screw and fit iron piping, he will have either the plumbers' or the fitters' delegates on his track, or both; and if he wishes to drill a hole, say, under 1 in. in diameter, in an iron bulkhead or deck, he must either wait till all the other hands have left the ship or employ a trades union driller. If he employs a driller, which of course he will do if much drilling work requires to be done, he still has the boilermakers' society to reckon with if he permits his driller to cut a hole above a certain size, a hole, say, for a bulkhead light. And when all is finished the poor wireman is not even allowed to run his plant, as *this* is fitters' work. As the joiners lay the wires in the grooves as they cap up, what, then, is left for the wireman to do? Apart from the laying out of the installation, which is generally done in the office, there are a few joints to make—very few in modern wiring with its distributing and looping systems, and a few fittings and switches to fix; any intelligent youth can do this without a three years' apprenticeship. This, then, is the work for which the Electrical Trades Union thinks a man should be paid 9½d. to 10½d. per hour! It is for this that a man must waste three precious years as an assistant and one year as probationer! Alas! the good old days, when a man could be sent to a job to fit up engine, dynamo, accumulators, wiring, fittings, and everything, turning his hand to anything, and finding his labour locally, and teaching his men, if need be, are gone, and the time is coming when it will be necessary to send out a small army of men to do the most trifling job.

No, no! before making stupid rules about overtime, tool lockers, and mess-rooms, let the Electrical Trades Union first settle with the other unions. Let them come to some sensible understanding which shall enable a wireman to use both his brains and his hands. Then, and not till then, will it be possible to form a union of skilled artisans—not half-castes who know no trade—men who will need no union rule to fix their rate of pay, but men whom contractors will be glad to employ, and, to use a hackneyed phrase, "pay a fair day's wage for a fair day's work."

The following draft rules have been forwarded to us by the secretary of the E.T.U., with the intimation that about 600 copies have been sent out, and are wanted returned by March 31st.:—

ELECTRICAL TRADES UNION.

Proposed Rules for Wiremen, Cable Jointers and Assistants employed in the London District.

1.—That 53 hours constitute a week's work, but when members are working on jobs where the hours are less, the money shall be made up to equal the 53-hour week.

2.—That 9½ hours constitute a day's work for five days in the week, and 5½ hours on Saturday, finishing work on that day at 1 p.m. Overtime on Saturdays, from 1 p.m. till 4 p.m., to be paid for at the rate of time and a half, after 4 p.m. double time. Overtime worked during the first five days in the week to be paid for at the rate of not less than time and a quarter for the first two hours, time and a half for the next two hours, and after that double time. Each day to stand by itself; night shifts to be paid for at the rate of not less than time and a half.

3.—That the rate of pay for wiremen and cable jointers shall be not less than 9½d. per hour, chargemen not less than 10½d. per hour. Apprentices, assistants and jointers' mates shall be not less than 17 years of age when entering the Society, and shall serve three years at the trade as apprentice, assistant, or jointer's mate, and one year as probationary member. The rate of pay during the probationary period to be not less than 7½d. per hour. No one shall be allowed to join as assistant, apprentice, or jointer's mate who is above the age of 21 years.

4.—Members working over one and less than 12 miles from shop to be allowed travelling time and expenses. Country expenses to be not less than 10s. 6d. per week. Travelling time and expenses to be paid for the journey from London to job, and from job to London.

5.—All members working on boats, under floors, in roofs, on accumulators, oil vessels, waterside premises, and other dirty jobs, must receive not less than 6d. per day dirty money.

6.—District holidays to be Easter Monday, Whit Monday, August Bank Holiday, Christmas Day and Boxing Day. That no holiday shall entail more than two days' loss of time. The rate of pay for Bank Holidays shall be not less than time and a half, Christmas Day and Sundays not less than double time.

7.—That no member in the London district be allowed to work more than one night in succession, namely, that after working all night our members must cease work at the usual time of leaving work the next day.

8.—One hour's notice to be given either side. Weekly wage employés to give and receive one week's notice. Members running casing to receive one hour's grinding money.

9.—That on all jobs requiring four or more men, not more than one assistant or apprentice to four men shall be employed.

10.—That no member be allowed to work overtime, unless absolutely necessary, when members in the district are unemployed.

11.—That on all jobs a lock-up for tools and materials be provided, and on building jobs, and where circumstances require, a mess room shall be provided.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS, 1901.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, to whom all inquiries should be addressed.

2,877. "Trolley guard wire safety device." D. S. Munro. Dated February 11th.

2,880. "An automatic contact maker and breaker." H. Garstang. Dated February 11th.

2,900. "Improvements in and relating to fusible cut-outs for electric circuits." H. M. Salmony & Co., Limited. (Elektrizitäts Actien Gesellschaft vorm W. Lahmeyer & Co.) Dated February 11th. (Complete.)

2,909. "Improvements in or relating to overhead trolley wires or conductors for electric traction overhead, electric cables, telephone, telegraph, or like wires." A. W. Hancock, J. Leighton, and R. Hacking. Dated February 11th. (Complete.)

2,933. "Improvements in electrodes for secondary batteries or accumulators." C. A. Wilde. Dated February 11th.

2,940. "An improved system for transmitting messages, particularly telephone messages." G. C. Marks. (L. W. Southgate.) Dated February 11th.

2,941. "Improvements in thermo-electric batteries." L. Gottschio. Dated February 11th.

2,962. "Improvements in guards for electric trolley wires." A. H. Gledhill. Dated February 12th.

3,002. "Insulator for electrical conduction wires." M. Harloe. Dated February 12th. (Date applied for under Patents, &c., Act, 1883, Section 103, September 19th, 1900, being date of application in United States.) (Complete.)

3,015. "Improvements in electrical alarm and other like apparatus." E. Whiting and R. C. Myddleton. Dated February 12th.

3,026. "Improvements relating to closed conduit electric railways." L. Dion. Dated February 12th. (Complete.)

3,030. "Improved method and means for holding and connecting the wires of telephone receivers and the like." F. G. Bell and M. Byng. Dated February 12th.

3,035. "Improvements in or relating to trolley or like current collectors for electric tramways and the like." F. E. Shaughnessy and G. J. Thomas. Dated February 12th.

3,036. "Improvements in or in connection with trolley or like current collectors for electric tramways and railways." A. B. Upham. Dated February 12th.

3,047. "Improvements in apparatus for regulating pressure in electric mains connected to storage batteries." J. S. Highfield. Dated February 12th. (Complete.)

3,061. "Electric generator." J. Stretch. Dated February 12th. (Complete.)

3,087. "Improvements in electric starting and regulating switches." A. H. Hickley. Dated February 13th.

3,111. "Improvements in systems of electric distribution." B. G. Lamme. (Date applied for under Patents, &c., Act, 1883, Sec. 103, July 14th, 1900, being date of application in United States.) Dated February 13th.

3,112. "Improvements in systems of electric distribution." B. G. Lamme. (Date applied for under Patents, &c., Act, 1883, Sec. 103, July 14th, 1900, being date of application in United States.) Dated February 13th.

3,113. "Improvements in rotary field magnets for electrical machines." B. G. Lamme. (Date applied for under Patents, &c., Act, 1883, Sec. 103, July 14th, 1900, being date of application in United States.) Dated February 13th.

3,123. "Improved insulating conduit for the conductors of electric tramways." P. C. Seguy. Dated February 13th.

3,127. "Improvements in guards or protectors for trolley wires and other electric conductors." S. Cristol. Dated February 13th.

3,133. "Improvements in means or apparatus for driving dynamos on railways and other vehicles from the axles thereof, and for connecting such dynamos and batteries to lighting, heating or other circuits on such vehicles." F. J. Beamont and W. M. Still. Dated February 13th.

3,164. "Improvements in electric ignitions for gas engines and motors." R. Hoyle and S. Wilson. Dated February 14th.

3,174. "An automatic self-adjusting circuit breaker." F. G. Evans. Dated February 14th.

3,177. "Improvements relating to electrical traction systems." E. G. Pulford. Dated February 14th.

3,179. "Apparatus for governing the output of dynamos when driven at different speeds." H. J. J. Hummel. Dated February 14th.

3,181. "Improvements in or applicable to dynamos and other electro-magnetic machines." F. J. Howitt and P. R. Jackson & Co., Ltd. Dated February 14th.

3,190. "Improvements in apparatus for controlling or breaking electric circuits." A. T. Smith, Jun., and P. R. Allen. Dated February 14th.

3,192. "Improvements in electric furnaces." P. Jurie. Dated February 14 h.

3,206. "Equalising appliances for inter-connected polyphase currents." Siemens Bros. & Co. (Siemens & Halske Aktien, Gesellschaft.) Dated February 14th. (Complete.)

3,207. "Improvements in telephone installations having a central microphone battery." Siemens Bros. & Co. (Siemens & Halske Aktiengesellschaft.) Dated February 14th. (Complete.)

3,221. "Improvements in safety appliances for electric trolley wires and cables." W. J. Nash. Dated February 14th.

3,234. "Improvements in or relating to electric ignition devices for explosion engines." W. Maybach. Dated February 14th.

3,247. "Improvements in or relating to safety guards for overhead electric wires." T. W. Redford. Dated February 15th.

3,250. "Improvements in and relating to call registers for telephones." W. H. Turner. Dated February 15th.

3,281. "A new or improved light amperemeter for electrical measures." H. E. Hart. Dated February 15th.

3,284. "Improvements in protectors for sparking plugs of petroleum motors with electric ignition." R. J. Paton. Dated February 15th.

3,288. "Improvements in or applicable to dynamos and other electro-magnetic machines." F. J. Howitt and P. R. Jackson & Co., Ltd. Dated February 15th.

3,291. "An anti-vibration base frame for explosion and other motors, dynamos, and other mechanism, appliances, or apparatus." G. Middleton, Dated February 15th.

3,310. "Improvements in and relating to electrical ignition devices for internal combustion engines." T. B. Browne and F. L. Martineau. Dated February 15th.

3,318. "Purifying beverages and liquids by means of manganates under influence of the electric current." W. P. Thompson. (Société Manganc Electrique pour la purification des eaux et des boissons.) Dated February 15th. (Complete.)

3,350. "Improvements in and relating to protectors for trolleys, wires of overhead driven electric tramways." J. T. Pearson. Dated February 16th.

3,353. "An improved safety guard to be applied to the trolley wires used for actuating electric tramcars." W. H. Cottam. Dated February 16th.

3,370. "Improvements in battery electrodes." J. Liddle. (The Globe Electric Company.) Dated February 16th. (Complete.)

3,376. "Improvements in electric arc lamps and electrodes therefor." C. A. Lee. Dated February 16th.

3,386. "Improvements in electrical heat radiators." J. Coley-Bromfield and W. H. Milnes. Dated February 16th.

3,387. "Device for automatically breaking circuit of trolley wires." A. E. Barber. Dated February 16th.

3,388. "Improvements in magneto-electric igniters." W. P. Thompson. (J. Boiron.) Dated February 16th. (Complete.)

3,390. "Improvements in switches or cut-outs for overhead electric wires." W. T. Smith. Dated February 16th. (Complete.)

3,390. "Improvements in secondary batteries." R. F. Yorke. Dated February 16th.

3,397. "Improvements in commutator brushes." Siemens Bros. & Co., Limited, R. Dumas, and C. R. Palairet. Dated February 16th. (Complete.)

3,398. "Improvements in or relating to overhead trolley wires for electric traction, overhead electric cables, telephone, telegraph wires, or the like." A. W. Hancock, J. Leighton, and R. Hacking. Dated February 16th.

3,401. "Improvements in apparatus for use in the electro-deposition of metals." S. O. Cowper-Coles. Dated February 16th.

3,402. "Improvements in apparatus for use in the electro-deposition of metal upon tubes." S. O. Cowper-Coles. Dated February 16th.

3,406. "Improvements in electrical apparatus for transmitting linear drawings." A. J. Boult. (A. Giorgi.) Dated February 16th.

3,411. "Improvements relating to electric accumulators." M. Pisca. Dated February 16th.

3,413. "Improvements in and relating to electric motor starting, regulating, controlling switches, and like apparatus." H. Hirst and W. White. Dated February 16th.

3,416. "Improvements relating to the construction of electrodes containing zinc for use in electric batteries, and method of producing and employing the same." W. Erny. Dated February 16th.

3,417. "Improvements in galvanic batteries." W. Erny. Dated February 16th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, Manchester and Birmingham, price, post free, 9d. (in stamps).

1899.

6,819. "Improvements in electric switches." W. F. Jones. Dated March 29th, 1899. Switches for controlling motors. Movement of the handle or wheel is transmitted to the switch arm through a magnetic clutch in the motor circuit, means being provided for momentarily closing the clutch circuit on the first movement of the handle. On failure of the current the clutch is disconnected, and the switch arm is swung back under the action of a spring or weight. An electro-magnet may also be provided to short-circuit the clutch should the current become excessive. The handle is fixed to the spindle which also carries the armature of the clutch electro-magnet. The magnet is fixed to a sleeve which also carries the switch arm which rubs over the contacts. With the first movement of the handle and armature, a projection on a cranked arm drops into a recess in the armature, and the other end of the arm makes contact, thus supplying current to the clutch electro-magnet, but not to the motor armature. Further movement of the handle now operates the arm. When "full on," the switch is held by a detent taking in a recess. The arm is returned by means of a spring or weight acting through a cord. The clutch is demagnetised by the overload magnet attracting its armature, and short-circuiting the magnet, or by lifting the armature by the rod. Movement of the handle is prevented, when the clutch is not operative, by a pin on the armature engaging with a projection on the lever. In a modification, the contacts may be arranged rectilineally, and operated through a rack. 3 claims.

6,820. "Improvements in or in connection with trolley or like current collectors for electric railways and tramways." E. Magrini. (E. Villa.) Dated March 29th, 1899. Electric railways and tramways with overhead conductors. The slack of the cord used for manipulating the trolley pole is taken up by the spring-wound barrel. The barrel is loose on the axle, and is recessed on one side to contain the spring, which is also confined by the cap. 3 claims.

6,833. "Improvements in step-by-step printing telegraph instruments." L. M. Casella. Dated March 29th, 1899. Relates to step-by-step telegraph receivers in which alternating impulses arriving from any suitable transmitter actuate at the receiving-station (1) a polarised electro-magnetic combination by a circuit for operating an escapement on the type-wheel shaft; (2) a magnet with non-polarised armature for controlling the circuit of the printing magnet. The armature is attracted during the passage of the alternating currents, and holds up the end of the lever from the heel of the lever. As soon as the current ceases, the lever drops on to the lever and completes the local printing circuit. The printing lever on rising, trips the lever by means of a cam and intervening lever, causing the lever to rest against an insulating face on the end. The lever produces the paper feed by means of a pawl acting on the paper wheel. A double wedge on the lever for shifting the type wheel axially by means of the pins when changing from letters to figures, or *vice versa*, is provided. The use of a pin unison device is referred to in the provisional specification. 4 claims.

6,873. "Improvements in or relating to accumulators or secondary batteries." P. Prestwich. Dated March 30th, 1899. Relates to a support for the active material, consists of a metal tube of circular or polygonal cross-section, and provided with longitudinal ribs, transverse division pieces and apertures. The active material is placed in the cells, and the tubes are preferably placed in a vertical position in the electrolyte. 1 claim.

6,874. "An improvement in telephones." Siemens Bros. and A. S. Schloemer. Dated March 17th, 1899. Portable telephones are arranged with the transmitter and receiver at the opposite ends of a handle, a vibrator for signalling purposes being also attached. Two keys, or a double-ended key for controlling the circuits of the transmitter and vibrator, are arranged in the handle. The circuits may be variously arranged; the transmitter may be omitted, and the receiver may also be arranged to act as the vibrator magnet. 1 claim.

6,228. "Means for taking and exhibiting cinematographic pictures." F. M. Lee and E. R. Turner. Dated March 22nd, 1899. Colour-printing telegraph receivers are arranged to work with Wheatstone transmitters sending alternating currents. The line currents are employed to operate a polarised double electro-magnet, the armature of which controls an escapement on the type-wheel shaft, and a non-polarised magnet, the armature of which is only released on the stoppage of the current to effect the printing. Two spring motors may be used, but these may be replaced by weight motors, or one of them by an electro-magnet in a local circuit. The type-wheel shaft is square, to allow the type wheel to traverse it but at the same time to rotate with it. The traversing of the type wheel is produced by the action of a pawl operated by the printing lever. The pawl acts on a ratchet wheel carried by the fast-pitched screw shaft, the nut of which carries an engagement for the type wheel, a bracket for the inking wheel, and a pointer moving over a graduated scale. The type wheel is brought to its zero position to begin a new line by means of a pin on the shaft engaging a stop on the link, when a spacing key is depressed at the transmitter; this releases the spring motor, and causes the shaft to run back. The shaft is also provided with a cam arrangement for striking a warning bell at any desired position. A second pin is placed on the shaft for engaging with a tripping device in the paper feed mechanism; this acts through rods on the escapement, allowing a ratchet wheel to make one revolution. The printing lever also is provided with winding-up mechanism for the paper feed, tripping devices for the release and to prevent overwinding being described. The provisional specification refers to Specifications No. 2,128, A.D. 1887, and No. 25,644, A.D. 1896, for similarity of details. 7 claims.

6,812. "Improvements in magnetic power transmitting devices." D. Bacon. Dated March 29th, 1899. Clutches, reversing gearing. Wheels each carrying a series of electro-magnets run loose on the driven shaft, and are geared to the driving shaft so as to rotate in opposite directions. An armature fast on the shaft is placed between the two series of magnets, and is carried around in one direction or the other according as to which series is energised from some suitable source of electricity. 2 claims.

6,982. "Improvements in apparatus employed in wireless telegraphy." G. Marconi and the Wireless Telegraph and Signal Co., Limited. Dated April 1st, 1899. Induction coils for use in wireless telegraphy such as is described in Specification No. 12,326, A.D. 1898. The primary coils are arranged in parallel or in series parallel, and the secondary, which may be formed of one or several sections, arranged in series and having a diminishing number of turns as the distance increases from the centre. A table is given in the specification showing the number of turns required for the different arrangements of coils, diameters of wires, &c. 3 claims.

7,284. "Improvements relating to telegraphic, telephonic, and like systems and to automatic switching apparatus therefor." L. J. Mathurin. Dated April 6th, 1899. (Date under International Convention, Oct. 10th, 1898.) Switching apparatus is arranged at each of a number of stations placed in one circuit, so that any station can call any other, and cut out all the remaining stations. The apparatus for one station consists of three buttons, 1, 2, 3, a line battery, a local battery, a rotatable cam, E, provided with a dial, two polarised relays, J', J'', an alarm, S, and a telegraph or telephone receiver. This receiver may be replaced by other apparatus, such as means for opening or closing a door, or a valve for water, air, or gas. The cam, E, is carried by a shaft, C, which is rotated, *b*, by clockwork or electro-magnetically, but is stopped by a pin, X, on it engaging a lever, Y, at the end of each revolution, and by a toothed wheel on it engaging an escapement lever, controlled by an electro-magnet, N, several times in each revolution; at each stoppage a pointer on the shaft, C, stands at a number on the dial. Each station corresponds to one number, and has its cam, E, suitably set on its shaft, C. Each relay may consist of a vertical solenoid containing a soft iron core carried upon a spring, its upper end being movable between the poles of a permanent magnet. The core of the one relay, J', normally touches a contact, short circuiting the electro-magnet, H, but is removable by a + line current. The core of the relay lies on either side; it is caused to close the local battery circuit by a − line current, and to open it by a + current. The buttons, 2, 3, send − and + currents respectively from the line battery to line. In calling, the button 2 is pressed once, then the button 3 a number of times corresponding to the number of the station called, and then again the button 2 once. The first current sent by the button 2 causes the relay, J', at each station to close the local battery circuit through an electro-magnet, the lever Y, and pin X, contact being thus broken between Y, X, and the shafts C freed and moving a step The + currents sent by the button 3 cause the relay J' to put the magnet H in circuit, and this to move the escapement lever, allowing the shaft, C, at each station to turn one step for each impulse of current. When the desired number is reached, the cam at that station moves an armature, A D, from a contact opening a short circuit across the receiver there. The armature, A D, at the calling station also moves similarly by an electro-magnet to which current is supplied from the local battery and a contact below the button 3. The armatures, A D, are then held by catches. When the button 2 at the calling station is depressed the second time, the relay J', at the desired station connects the alarm S, with the local battery through the armature, A D, and cam E. The station called answers by depressing its buttons 1 and 2; the first button sends a local current through a second winding on its relay J', opening the circuit of its alarm S, and the second rings the alarm at the calling station. If the station called does not answer, or when a communication is finished, the button 3 is pressed repeatedly, returning all the station switches and cams to the starting position; a second cam on each shaft C then raises the armature, A D, to move back to the contact. All the stations can be called simultaneously by pressing the botton 3 till the shaft C have made nearly a whole revolution, when a projection on each makes contact with a spring to connect the electro-magnets with the local batteries by a connection, and move the armatures, A D. Similar connections may be made to all stations for setting clocks, A P, from a central clock once a day, the springs A M being connected to regulating electro-magnets in the clocks, as shown. The central clock may automatically release a rotary spring-driven cylinder provided with pins to send the necessary line currents in proper order, beginning by a sufficient series of + currents to set all the switches to the starting position. Other small modifications may be made. 6 claims.

7,321. "Improvements in secondary battery plates, grids, and the like." W. A. Gent. Dated April 7th, 1899. A plate or grid for supporting the active material consists of a number of parallel ribs joined together by strips which are joined alternately to the top and bottom of adjacent ribs. 2 claims.

7,364. "Improvements in or relating to means for controlling and indicating the supply of electrical energy." H. Kunkelmann, C. E. Francois, and C. R. Louberg. Dated April 7th, 1899. Maximum demand indicators, and electro-magnetic switches for limiting the supply of current to consumers by automatically repeatedly breaking and making the circuit if excess current is used, are provided with means controlled by an electro-magnet and special wires from a central station for altering the current allowed at any time. The electro-magnet may connect a shunt resistance or rheostat to an ordinary limiting switch or demand indicator, as described in Specification No. 6,032, A.D. 1899, in connection with supply meters. Or the limiting switch or a thermal U-tube demand indicator may be made with two different coils, either of which can be connected in the supply circuit by the electro-magnet, special controlling wires, and a switch. 4 claims.